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NIGHT ROOSTING AND 'LUNAR PHOBIA' IN INDIAN FALSE VAMPIRE BAT *MEGADERMA LYRA*[1]

R. SUBBARAJ[2] AND J. BALASINGH[3]

(*With seven text-figures*)

Key words: *Megaderma lyra*, moon light intensity, night roosts, foraging, lunar phobia

'Night roosts' of Indian false vampire bats *Megaderma lyra* include cow-sheds, unoccupied buildings, ranging from small store rooms to large country houses. Observations of adult females occupying the night roosts suggest that the duration of occupancy of night roosts and the duration of foraging bouts vary depending on the phases of the moon and the reproductive conditions. Moon light avoidance (reflected by the duration of occupancy of night roosts) is significantly higher during breeding season than during non-breeding season in females. The behaviour of 'lunar phobia' in male *M. lyra* follows the patterns exhibited by the females. It is possible that in *M. lyra* 'lunar phobia' is probably an adaptation for reducing losses to nocturnal predators that are at least visually oriented.

INTRODUCTION

"Night roosts" of bats include places used to ingest food transported from nearby feeding areas, used by "sit and wait predators" and calling roosts as part of leks. They may also serve as centres for information transfer about the location of food patches and facilitate social interaction (See review Kunz 1982). Bats roost for short intervals in the night roosts to consume prey that they have captured in flight or on the ground. This behaviour seems most common in those bat species that take relatively larger prey. For example the intermittent returns and departures of *Antrozous pallidus* at night roost (Orr 1954, Beck and Rudd 1960, O'Shea and Vaughan 1977) commonly involve the transport of large insects. The selection and the duration of occupancy of night roosts may be influenced directly or indirectly by lunar periodicity. For instance, some desert bats apparently use more protected shelters during brighter lunar periods than during darker ones (Hirshfeld *el al.* 1977)

We have gathered data concerning the foraging behaviour of *M. lyra* from radio-tracking studies (Doris *et al.* 1991). The foraging bouts of these bats in relation to different phases of the moon. In this present study the inhibitory effects of moon light on the foraging is related to the "night roosting" behaviour in these bats.

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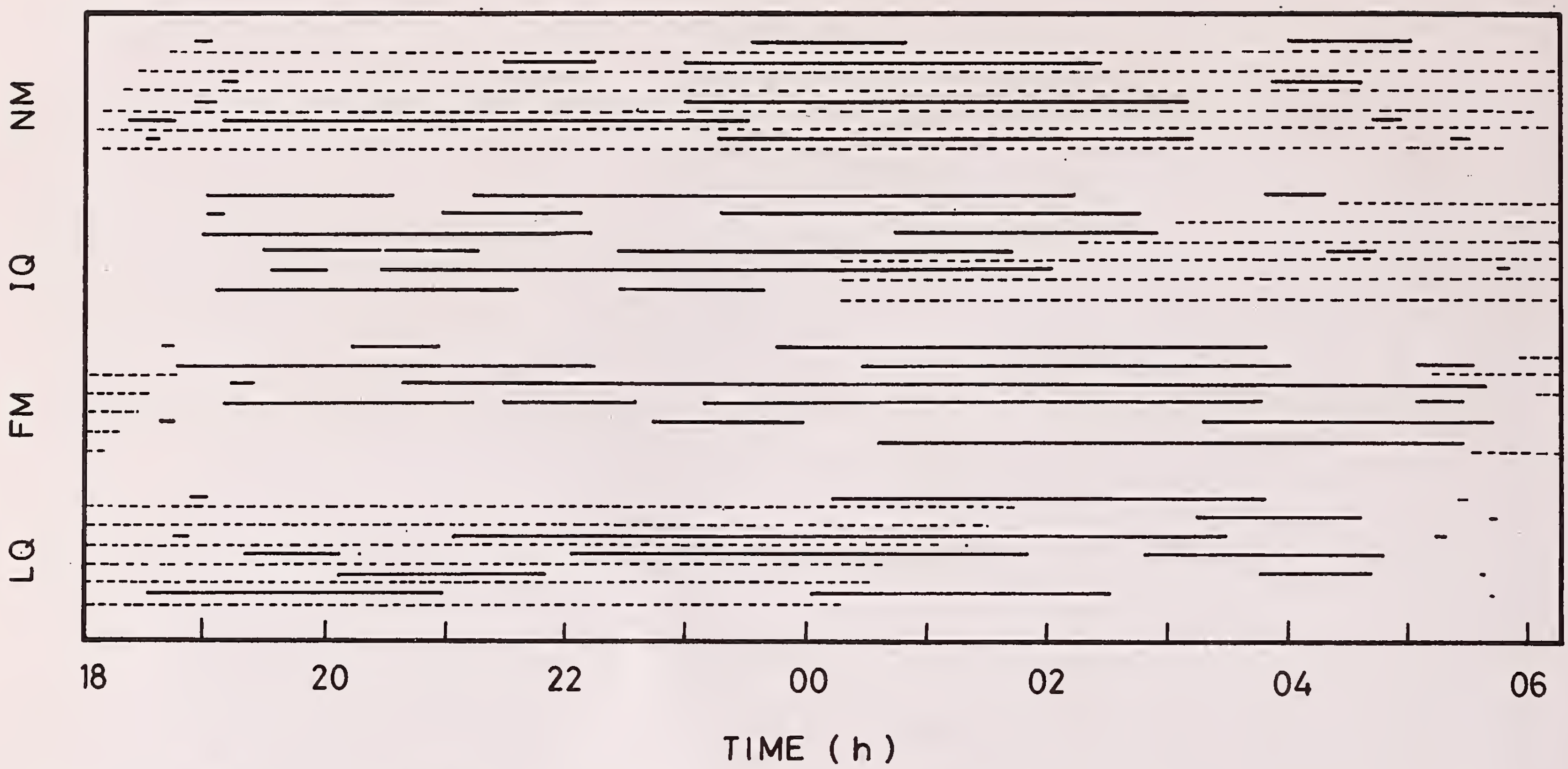

Fig. 1. Foraging activity of tagged *M. lyra* relative to the phase of the moon. Each horizontal solid line (______) represents the time spent in the "night roost" by a single female. Dotted lines (----------) cover those hours of the night when the moon is either set or not yet risen.
The time spent in the night roosts (______) by *M. lyra* is plotted subsequently just above (----------) "dark hours" of the night.
Abbreviations: NM — New moon; IQ — First Quarter; FM — Full moon; LQ — Last Quarter.

MATERIALS AND METHODS

The night roosts of *M. lyra* were mostly located 50 m to 500 m away from the diurnal temple roost (Tirunelveli, lat. 8° 44' N; long. 77°42' E, South India). They include cow-sheds, unoccupied buildings, ranging from a small store to large country houses. Bats were banded with plastic collars fitted with beads of different colours and combinations to enable individual identification of bats while night roosting (Balasingh *et al.* 1992). Weekly visits covering 36 nights representing all the lunar phases were devoted completely from dusk to dawn for observing banded *M. lyra* at night roosts. Interestingly one banded female *M. lyra* night roosting continuously in an unoccupied house was observed for 12 nights during the breeding season (February, March and April 1989) and for 12 nights during non-breeding season (September, October, and November 1989). Another banded male *M. lyra,* night roosting in a small two chambered temple was observed for 12 nights during the months of February, March and April 1989. Bats were observed from a distance of less than 5 m with a red filtered lamp or night viewing device (Litton Precision Noctovision Sniperscope). The time spent by the bat in the night roost was recorded with a stop-watch. Timings of moon rise and moon set were obtained from the tables of Ephemeris Nautical Almanac published by the Director of Observatories, Calcutta and were adjusted for longitude, latitude and Indian Standard Time (IST).

RESULTS

M. lyra night roosted singly and not in groups. Night roosts tend to be favoured places situated 50 m to 2 Km from the day roost. During breeding seasons most of the lactating females night roosted 50 m to 500 m from the day roost. During rainy months most of the night roosts were closer to day roost while during the long summer, these night

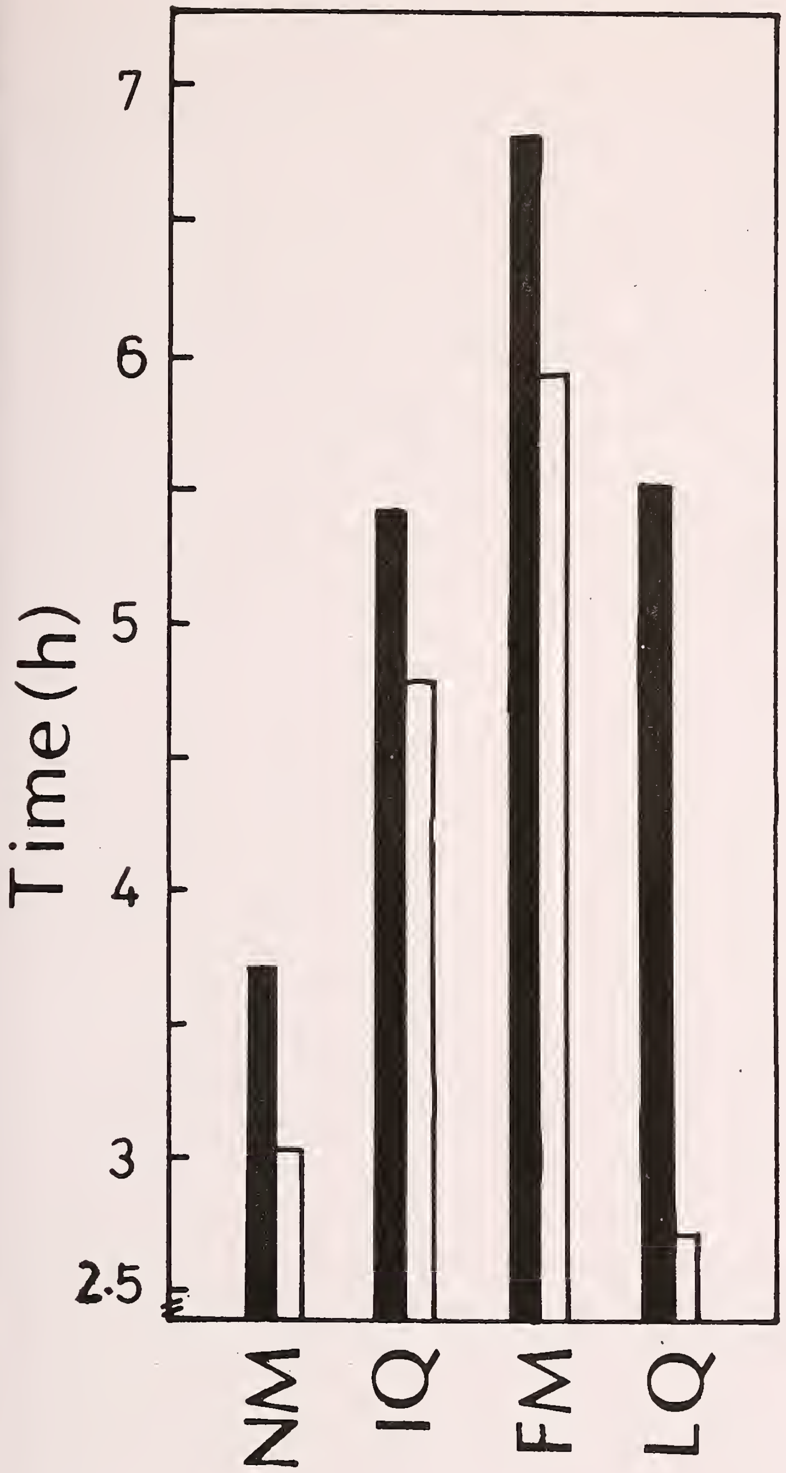

Fig. 2. Time duration of night roost occupancy by female *M. lyra* (ordinate) in relation to different phases of moon.
NM — New moon; IQ — First Quarter;
FM — Full moon; LQ — Last Quarter.
■ Breeding; □ Non-breeding.

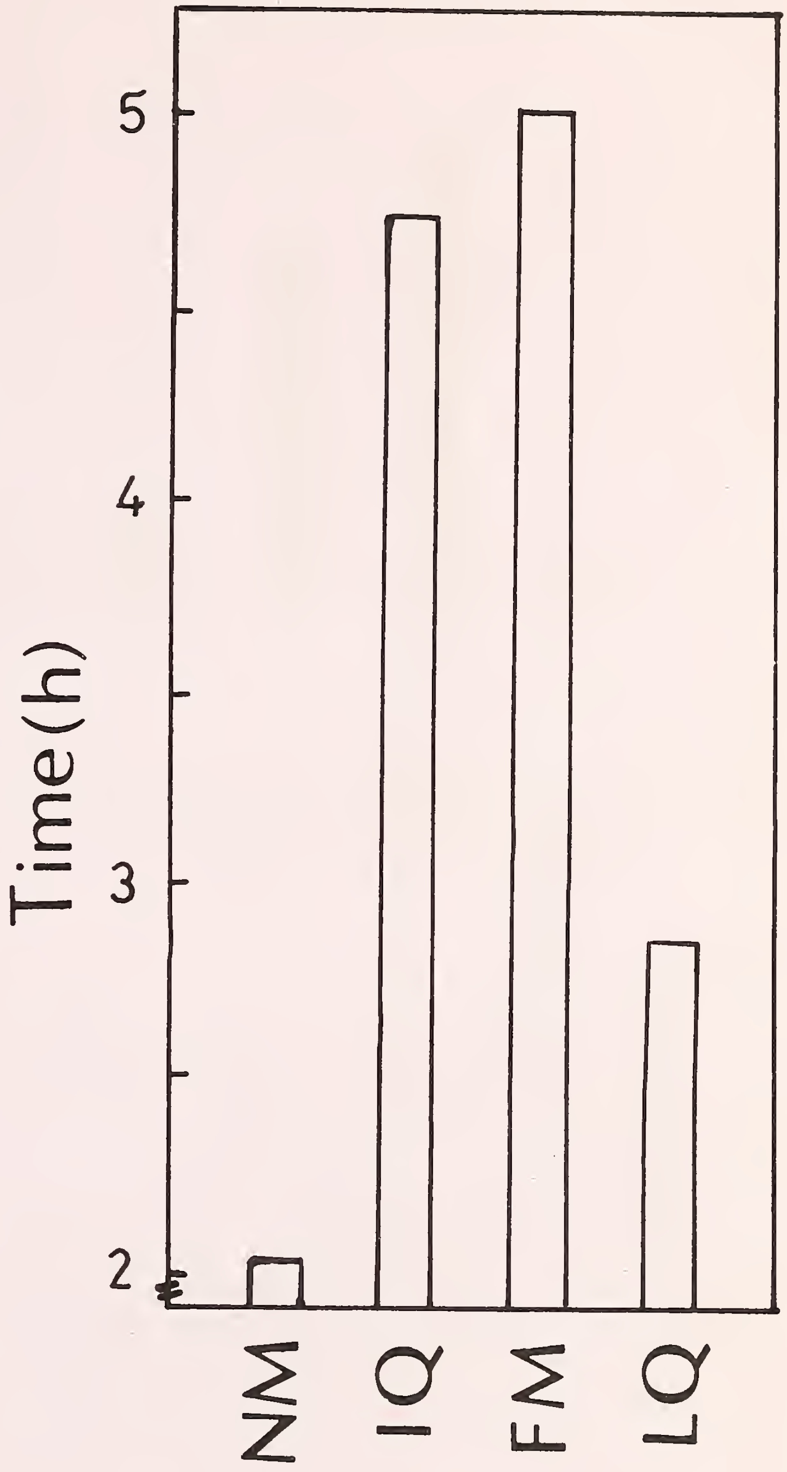

Fig. 3. Time duration of night roost occupancy by male *M. lyra* (ordinate). Other details as in Fig. 2.

roosts were temporarily vacated by the bats.

An adult female bat continuously occupied the night roost for more than 6 months. Variations in the patterns of foraging by this single female *M. lyra* were correlated with the phases of the moon. During new moon nights the bats engaged in prolonged foraging bouts and as a result the duration of occupancy in the night roosts were greatly reduced. During first half of the "bright moon" nights (first quarter moon) the bat suspended foraging activity and prolonged the stay in the night roost (Fig. 1). From the first quarter to full moon, despite the presence of a relatively bright moon at sunset, the *M. lyra* female left the day roost at the usual time but stayed away long enough to complete one or two

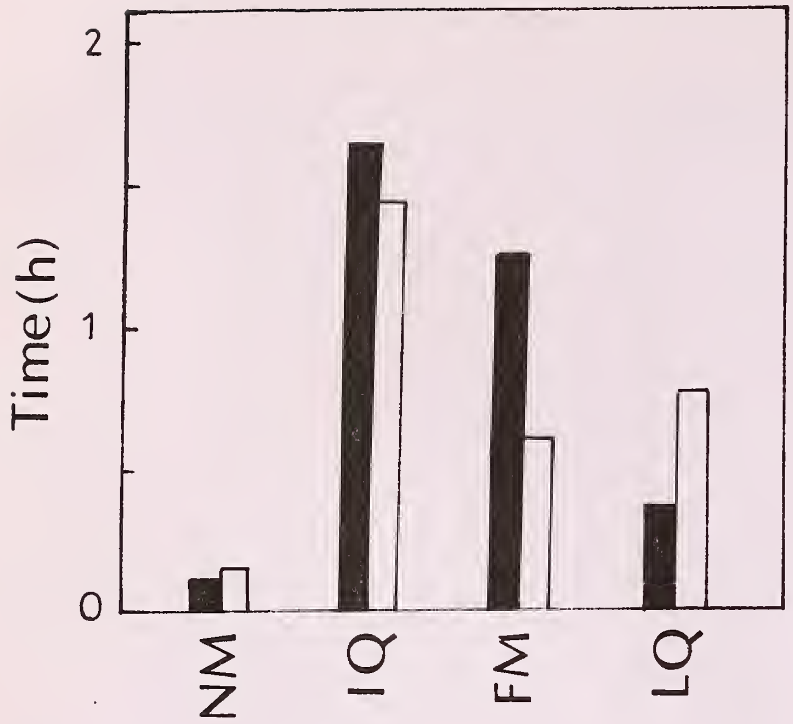

Fig. 4. Time duration of I bout night roost occupancy (ordinate) in breeding (■) and non-breeding (☐) female. Other details as in Fig. 2

feeding passes before returning to the night roost.

During full moon nights, even though there was an occurrence of two or three feeding bouts they were of shorter duration. The duration of occupancy in the night roosts was significantly higher.

During most of the nights, at moon-set this female *M. lyra* re-emerged from the night roost and foraged till dawn. These data on the influence of moon phases on the foraging activity of the female *M. lyra* differs significantly during breeding and non-breeding seasons. Fig. 2 shows clearly that the time spent in the night roost by the female *M. lyra* was significantly higher during breeding season compared to the non-breeding season during all phases of the moon. During last quarter, however, the female spent significantly lesser time in the night roost during non-breeding season than in the breeding season (Fig. 2).

Figure 3 illustrates the dependency of the duration of the night roost occupancy in an individual male on the lunar periodicity. The pattern follows those exhibited by the female. During "bright moon" hours the male returned to the night roost and remained there for a long time.

Figure 4 illustrates the duration of stay (I bout) in the night roost by the female. The time spent in the night roost was relatively higher during "bright moon" hours of the first quarter moon and full moon nights. The results are also in agreement with the data collected for subsequent bouts in the night roosts (Figs. 5, 6 & 7). Even though there were variations in the time spent during different bouts in the night roost by the female during breeding and non-breeding seasons, the results of cumulative data collected for all the rest of the bouts suggest that during breeding season the moon light avoidance is significantly higher than during non-breeding season.

DISCUSSION

Bats are "faithful" to individual night roost as long as the nearby area remains resourceful. During rainy months most of the night roosts are closer to day roosts since the ponds and the neighbouring fields are flooded with water yielding rich food resources. During long summer months bats make long commuting flights between foraging grounds and night roosts, hence several of the night roosts were temporarily shifted to distant places which are rich food resources.

The lactating females "night roosted" close to day roost during breeding season because the mother bats carried their young to the night roost and left them in the night roost while they foraged. Since they have to carry the extra baggage the mother bats preferred to night roost closer to the day roost during breeding.

The first indications of moon light avoidance behaviour were given in the observations of Tamsitt and Valdivieso (1961), Villa (1966), Wimsatt (1969), Schmidt *et al.* (1971) and Crespo *et al.* (1972) who could catch less number of foraging vampire bats and phyllostomids in their nets at moonlit nights than they could before the moon had risen or after it had set. A direct proof of the inhibitory effects of moon light was, however, obtained only after months of recording the flight activity of several captive bats such as *Artibeus jamaicensis* and *Phyllostomus discolor* under natural lighting conditions (Erkert

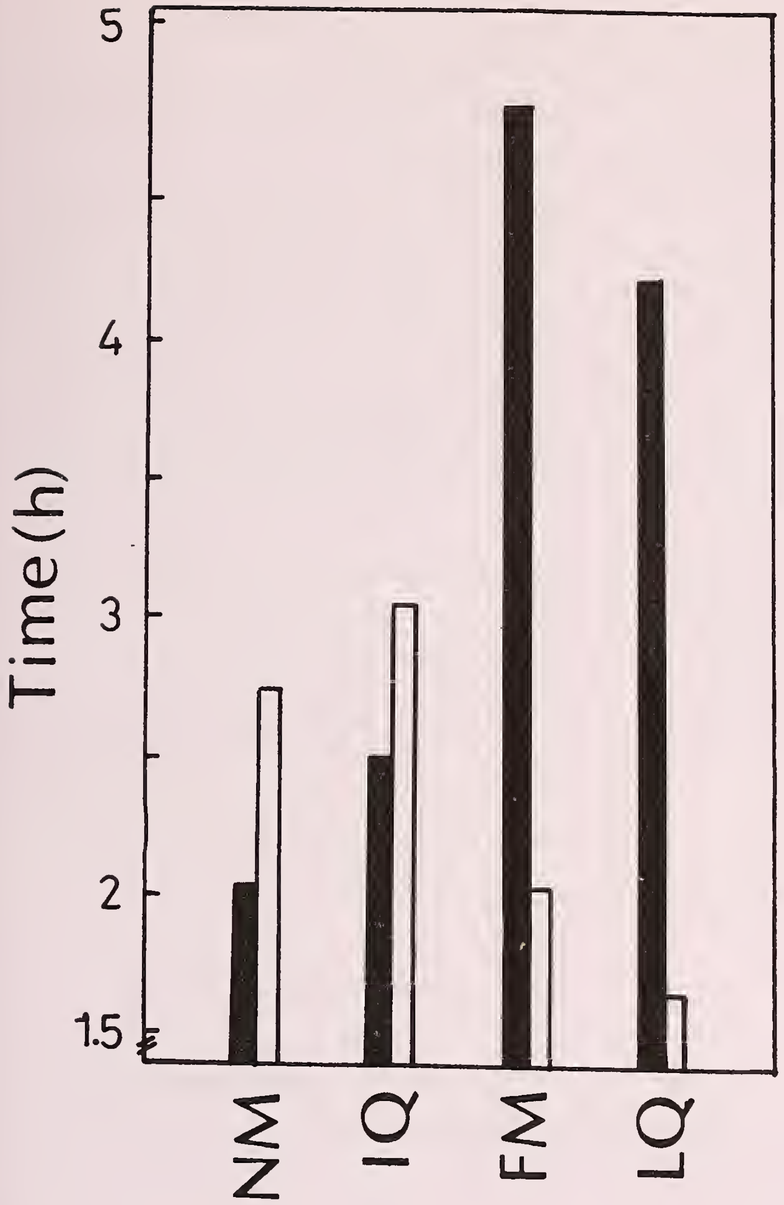

Fig. 5. Time duration of II bout night roost occupancy (ordinate) in breeding (■) and non-breeding (□) female. Other details as in Fig. 2.

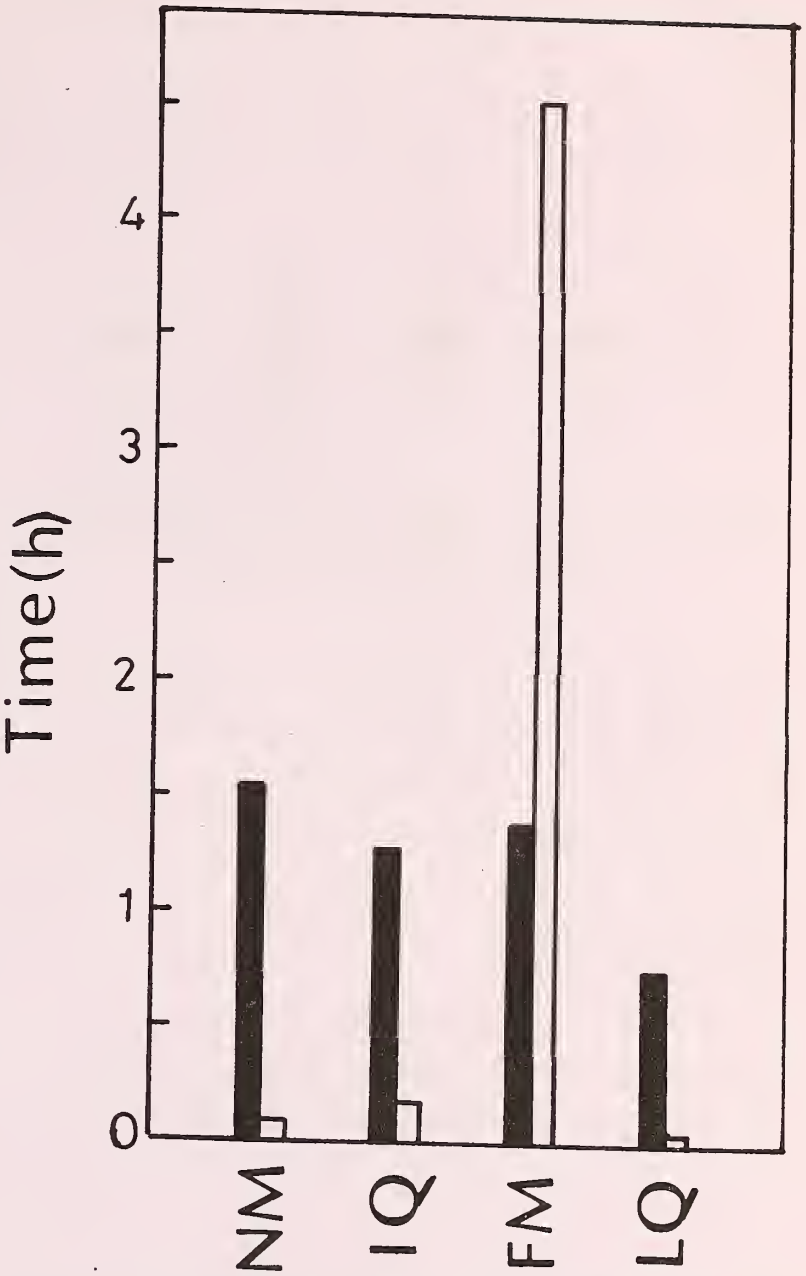

Fig. 6. Time duration of III bout night roost occupancy (ordinate) in breeding (■) and non-breeding (□) female. Other details as in Fig. 2.

1974). The findings of the studies have since been confirmed with a number of techniques, including the radio-tracking of *A. jamaicensis* (Morrison 1978a, b), bat detector recordings of the activity of various microchiropterans (Fenton *et al.* 1977) and simulation experiments on *A. lituratus* and *P. hastatus* in artificial light-darkness cycle in the laboratory (Haussler and Erkert 1978).

In addition, the differential sensitivity of bat activity patterns to moon light could also serve to reduce the direct interspecific competition among bats specialising on particular food resources by temporal separation of foraging activity based on the lunar cycle. Such a mechanism was proposed, for example, by Owings and Lockard (1971) for two rodent species of *Peromyscus* with differential responses to moon light intensities.

The moon light avoidance behaviour of *M. lyra* is not cued simply to ambient light level. *M. lyra* left the day roost after sunset even on nights when a bright moon was already present. At sunset, hunger may be an over-riding factor, causing the bats to emerge for a short bout of feeding despite the illumination from the full moon. Furthermore, the data of Lockard (1978) from field work measuring activity of kangaroo rats throughout the full range of naturally occurring conditions do clearly show that light intensity alone is not the cue, for much

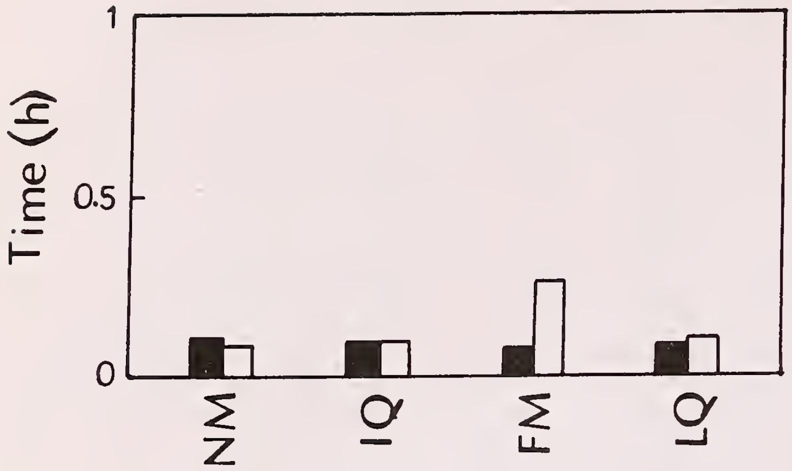

Fig. 7. Time duration of IV bout night roost occupancy (ordinate) in breeding (■) and non-breeding (□) female. Other details as in Fig. 2.

activity also occurred about the time of civil twilight (sun 6° below the horizon) when the illumination was about 10 lx. Whereas the full moon was on the order of 0.5 lx. Later, when there was much less illumination but a luminous disk was in the sky, activity was inhibited. Thus any of the three following hypotheses could account for the observed behaviour in *M. lyra*:

(1) Activity is inhibited by any reasonably conspicuous luminous disk in the sky.

(2) Activity is inhibited by a luminous disk in the sky that provided the ambient illumination which is above some threshold point.

(3) Activity is inhibited by an endogenous clock running on lunar time.

The limited data available in the present study permitted to analyse only the influence of the lunar periodicity on the night roosting behaviour in *M. lyra.* In this context, it is of interest that moon phases influence the activity of several bats directly or indirectly acting through changes in behaviour, abundance or availability of prey (Turner 1975).

We do not have complete data on the prey abundance at different moon phases over the seasons. However, it is possible that in *M. lyra* similar to other bat species "lunar-phobia" is probably an adaptation for reducing losses to nocturnal predators that are at least visually oriented (Lockard and Owings 1974, Lockard 1978, Morrison 1978a; Barclay 1985a,b; Fleming and Heithaus 1986).

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RELATIONSHIP BETWEEN DIVE AND POST-DIVE PAUSE WHILE FORAGING IN TWO DIVING DUCKS OF LAKE MANSAR[1]

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(*With three text-figures*)

Key Words: dive, pause, ducks, relationship, diving

Relation between dive and post-dive pause while foraging is quantified in the two diving duck species: Common pochard (*Aythya ferina*) and Tufted duck (*A. fuligula*) that winter in Lake Mansar, Distt. Udhampur, J&K. A total of 1641 dive cycles (981 dive cycles for Tufted duck and 660 for Common pochard) were observed during the winter 1992-93. In both the species positive relationship between dive time and post-dive pause has been analysed by Karl Pearson's Co-efficient of correlation (r) method. However, such positive relationship is more in Common pochard ($r=0.88$; $t>0.05$) than in Tufted duck ($r=0.65$; $t>0.05$). This has been correlated with the diet difference of the two ducks. Common pochard which is largely a vegetarian shows increase in pause time with dive time as compared to Tufted duck which feeds on sessile or slow moving benthic prey.

Long dives (21 sec. and above) are observed more in Tufted duck than Common pochard. This difference in dive time is influenced by diet difference and foraging decisions made while underwater.

INTRODUCTION

Foraging style of diving birds, that dive from surface of water and after spending some time underwater, returns to the water surface to breathe is well known (e.g., Johnsgard 1965, Wallace and Mahan 1975, Ali and Ripley 1978, Lessells and Stephens 1983, Ydenberg 1986, Woakes and Butler 1986). Similarly considerable literature on physiology of diving is also available. Butler and Jones (1982) in their review "Comparative physiology of diving in Vertebrates" listed almost one thousand references. In contrast, publications of diving behaviour and particularly on the relationship between dive and pause is very scarce.

Diving behaviour of birds hold great fascination not only among ornithologists but also among naturalists and this can be summed up from a Scottish physician and naturalist J.M. Dewar's (1924) statement: "Among the problems surrounding the life of birds, none is more fascinating than the underwater activities of diving fowl".

In this paper, we describe briefly some of our studies on the comparative relationship between dive length and post-dive pause when freely foraging, in the two *Aythya* species, i.e. Tufted duck *A. fuligula* and common pochard *A. ferina,* that winter in lake Mansar. The starting point is the common place observation that although some dives by birds are made during courtship or to escape predators, most are made to capture food.

STUDY AREA

Lake Mansar (32°42' N and 75° E) is a heart shaped sub-oval water body, 65 km to the east of Jammu city (J&K), and is located at an elevation of 710 m above msl. The lake is 37 metres deep at the centre, and has a circumference of 3.294 Km. It is primarily fed by surface run off, and has some submerged spring sources. It is classified as a fault basin, non-drainage, type of lake without any distinct regular inflow or outflow channel.

The lake is utilized by a number of migratory aquatic birds in winter.

METHODS

This study was conducted during the winter of 1992-93 in a lake Mansar. Birds were watched

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and observation recorded for the duration of their sequential dives and surface pause after re-emergence using a stop-watch. Total of 1641 dive cycles (981 for Tufted duck and 660 for Common Pochard) were observed. Only one bird (of either of the two diving duck species) was observed at a time. During the present work only those dives were taken into consideration which were made for foraging. Divers make repeated foraging excursions from the surface to which they must return to breathe (Ydenberg 1986), though some distance away from where they dive. Thus the underwater time and the post-dive pause which is spent on the surface, completes a dive cycle. During a dive cycle, the bird under observation may get disturbed, by one way or the other on quite a few occasions, particularly during emergence at surface, thus either lengthening the post-dive pause or forcing the bird to dive. All such observations were deleted from the data so that we have a data set purely of free foraging dive cycles.

To compare the post-dive pause time to its preceding dive length time, all the observations were grouped that were made under similar dive length time (in seconds) and then the mean ± S.D. of all the post-dive pauses were calculated for each group of similar dive length (Table 1).

To analyse any correlation between dive length and post-dive pause, statistical method of Karl Pearson's co-efficient of correlation (r) was applied to the data-

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \times \Sigma y^2}}$$

Where $x = (X-\overline{X})$ and $y = (Y-\overline{Y})$

X is the dive length,

Y is the mean post-dive pause time,

$\overline{X}$ is the mean dive length of the data,

$\overline{Y}$ is the mean pause time of the data,

To test the significance of the observed Co-efficient of Correlation (r), t-test has been applied as follows:

$$t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

Where 'n' is the d.f.

Regression analysis has also been worked out to estimate values of pauses (Y) at independent values of dive (X).

Regression equation of Y on X is expressed as follows:

$Y = a + bX$

X (dive) is the independent variable and 'a' and 'b' are constant having values of

$a=7.17$ and $b= 0.26$ in Tufted duck.

$a=3.6$ and $b= 0.49$ in Common pochard.

RESULT AND DISCUSSION

Table 1 and Fig. 1 summarizes comparative data on dive length and post-dive pause relation-

TABLE 1

COMPARATIVE ACCOUNT OF POST-DIVE PAUSE LENGTH TO ITS PRECEDING DIVE LENGTH IN THE TWO DIVING DUCK SPECIES IN LAKE MANSAR

Dive time (in seconds)	Pause time in Tufted duck Mean ± S.D	Pause time in Common pochard Mean ± S.D
6		7.33 ± 2.51
7		6.66 ± 2.08
8		7.66 ± 2.08
9		7.00 ± 3.82
10		8.75 ± 3.59
11	9.00 ± 0.00	10.25 ± 4.99
12	10.00 ± 0.00	13.33 ± 4.04
13	—	10.50 ± 4.94
14	9.50 ± 1.00	11.00 ± 4.21
15	12.75 ± 2.62	12.33 ± 4.21
16	12.50 ± 3.80	10.00 ± 1.41
17	9.54 ± 2.25	10.12 ± 5.20
18	12.40 ± 4.30	12.80 ± 2.28
19	14.98 ± 4.97	12.50 ± 3.50
20	15.78 ± 7.62	15.11 ± 1.83
21	13.53 ± 6.77	13.22 ± 1.39
22	12.03 ± 3.31	14.84 ± 2.70
23	12.90 ± 2.25	17.14 ± 4.52
24	15.59 ± 5.30	14.00 ± 3.81
25	13.27 ± 4.09	14.33 ± 4.16
26	13.23 ± 4.62	13.60 ± 3.13
27	13.90 ± 3.58	14.10 ± 3.69
28	13.36 ± 3.86	15.00 ± 4.69
29	11.35 ± 2.89	15.80 ± 1.78
30	14.18 ± 4.35	22.16 ± 2.40
31	19.75 ± 4.11	25.00 ± 6.85

ship in the two diving ducks *Aythya fuligula* and *A. ferina* in Lake Mansar. In both the species positive relationship has been worked out, i.e. $r=0.88$ in Common pochard and $r=0.65$ in Tufted duck, both of which are significant at 5% level (i.e. $t > 0.05$).

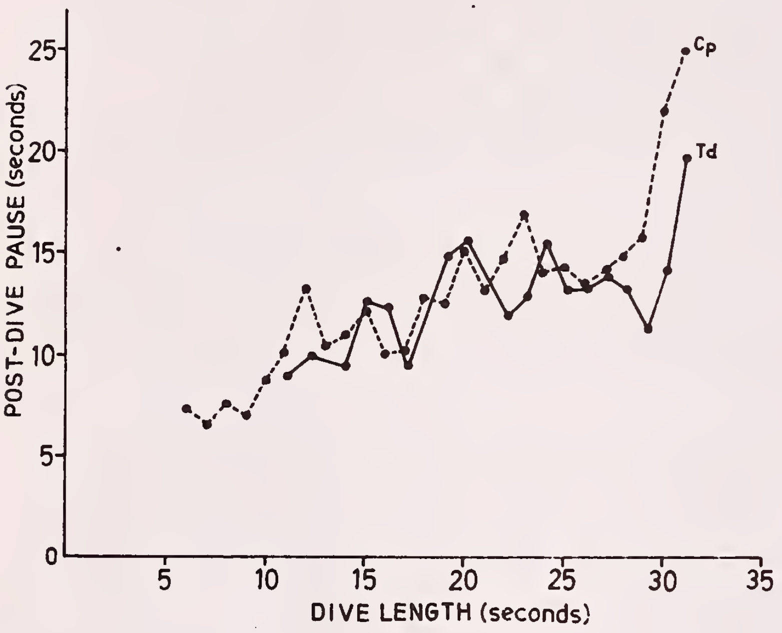

Fig. 1. Dive-pause relationship in the two diving ducks: Cp — Common pochard and Td — Tufted duck. Each point is the mean of 10 to 132 dive cycles.

Similar to our observation, Dewar (1924) has also shown positive relationship with significant increase in pause time with dive time in diving ducks and other divers (including loons, grebes, cormorants and auks). Positive relationship between dive and pause duration has also been worked out by Forbes (1985) in Western Grebe *Aecmophorus occidentalis*, and Stonehouse (1967) in cormorants *Phalacrocorax melanoleucos* and *P. carbo*. Houston and McNamara (1985) developed a general theory of central place foraging for single prey loaders that takes account of the fact that longer dives are followed by longer pauses. Data from a variety of species show that pause duration is directly related to the length of the preceding dive which strongly suggests that this is, at least, partly, recovery time during which respiratory gases are exchanged (Butler and Woakes 1979). Comparative data on dive and surface times suggest that different species, depending on their foraging ecology, allocate the recovery time from dives in different ways, such as, divers whose prey may escape or hide between dives (e.g. fish) may postpone recovery to dive more frequently until a series of dives has been completed. Divers whose prey are sedentary (e.g. shellfish) seem to complete much more of the recovery after each dive (Ydenberg 1986). Diving is energy expensive (Woakes and Butler 1983, 1986) and divers spend much time underwater. Time spent on surface is used for recovery from physiological effects (partial asphyxiation) which may be a consequence of diving and underwater life as also suggested by Ydenberg (1986) and Ydenberg and Forbes (1988). Alongside, body heat lost while underwater may be regained while on the surface after a dive as also suggested by Mac-Arthur (1984).

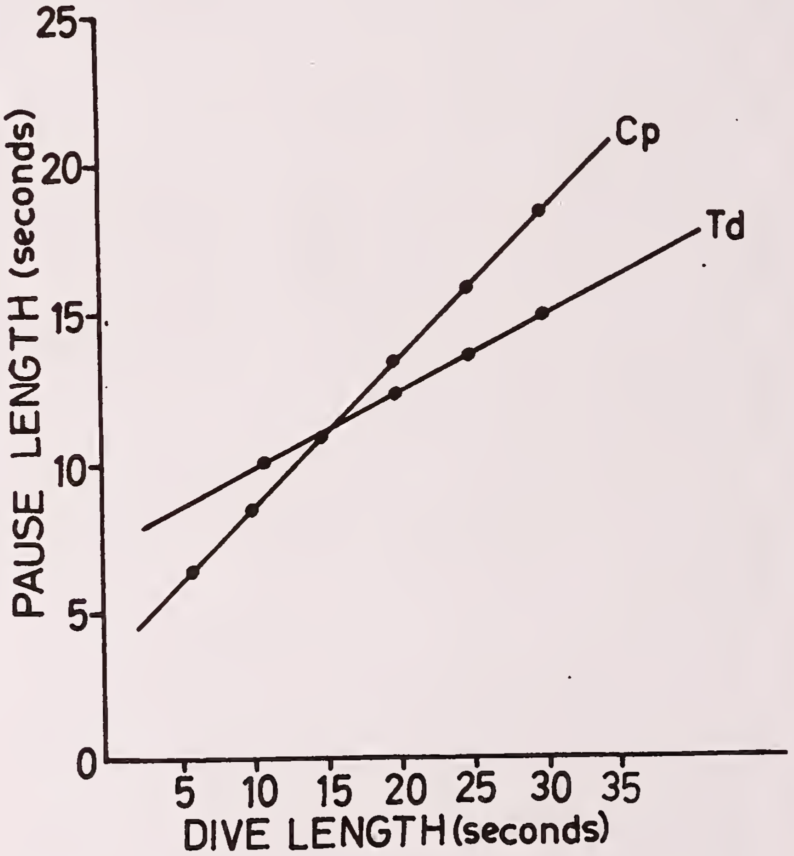

Fig. 2. A comparison of the dive-pause relationship in Common pochard (Cp) and Tufted duck (Td) by Regression analysis.

Of the two diving ducks, Common pochard shows more increase in pause time with increase in dive time than in Tufted duck, i.e. regression line for pause time is steeper in case of Common pochard than in Tufted duck (Fig. 2). This difference can be related to the difference in diet of the two species.

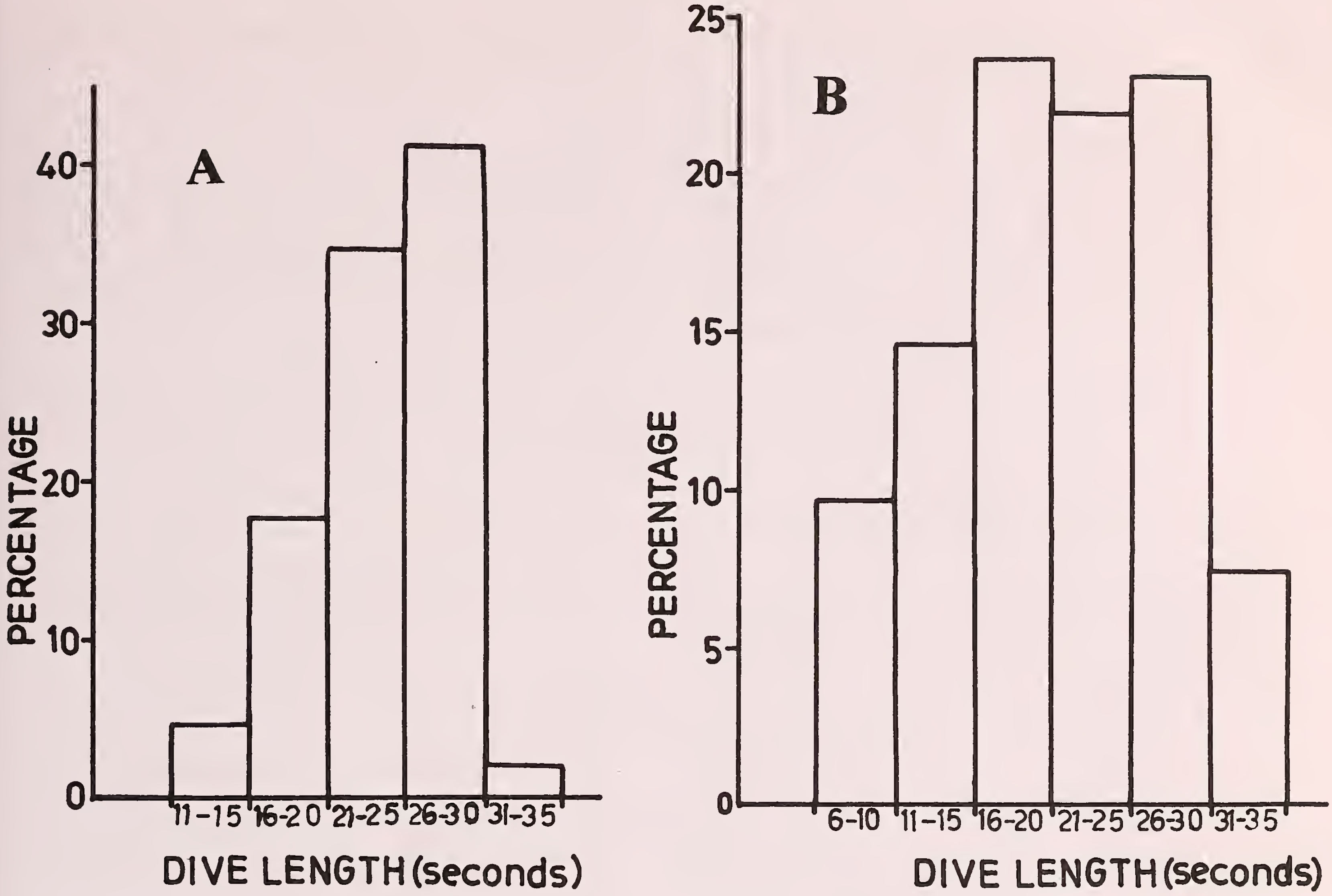

Fig. 3 Percentage of dives made at a frequency of 5 seconds in (A) Tufted duck; (B) Common pochard.

That Common pochard is more a vegetarian than the Tufted duck, is well documented by Ali and Ripley (1978). Ydenberg (1986) also explains that difference in observation of Dewar (1924) where steepest slope is for diving ducks as compared to other divers like mergansers, loons, grebes, cormorants, etc., is suggested to be due to different diets of the latter from former. The diving ducks generally feed on sessile or slow moving benthic prey such as shellfish and crustaceans (Nilsson 1972, Pehrsson 1976, Ali and Ripley 1978) whereas other species (mergansers, loons, grebes, cormorants) which capture fish in active pursuit. Ydenberg (1986) explains that short pauses *are advantageous* because prey may escape between successive dives.

When dive time of the two ducks is compared for same time (21 seconds and above), we find Tufted duck diving for this duration on 77.5% of the total observation (Fig. 3, A), whereas Common pochard does so for 52% of the total observations only (Fig. 3, B). The difference in dive duration is influenced by diet difference in the two species as already stated and also by the foraging decisions (Stephens and Krebs 1986) made while underwater, namely which prey to eat and which to neglect or how many prey to capture and how long to continue a search before surfacing. Houston and McNamara (1985) concluded that, for a diving bird, the decision policy, for accepting and rejecting prey items, is in favour of that which maximizes the rate of energy gain which makes the bird less and less selective as the dive progresses, because rejection becomes more and more costly.

CONCLUSION

Data collected and analysed thus shows positive relationship between dives and post-dive pause, i.e. with increase in dive time, post-dive pause also increases. Such relationship in dive-pause is well supported by reports of other investigators also. Dive-pause relationship is more in Common pochard than in Tufted duck and is well explained by the difference in diets of the two species. Further it is observed that on an average Tufted ducks go for longer duration of dives and on more occasions than Common pochard do, which can be related to their differences in diet and foraging decisions made while underwater.

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NOTES ON THE FEEDING AND BREEDING BEHAVIOUR OF *GYMNOPLEURUS GEMMATUS* HAROLD AND *GYMNOPLEURUS MILIARIS* (F.) (COLEOPTERA: SCARABAEIDAE)[1]

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(With a text-figure)

Key Words: *Gymnopleurus gemmatus, G. miliaris,* nesting, competition

Field studies on the feeding, mating and competitive behaviour of *Gymnopleurus gemmatus* and *G. miliaris* were conducted in Bangalore. Both the species were diurnal and fed both at the pat and on dung balls that they fashioned, transported and buried before feeding. Competition was intense both for dung balls and mates within the species and for dung balls alone between the species. Species belonging to the genera *Onthophagus* and *Caccobius* were found frequently as kleptoparasites in the brood balls of these beetles.

Introduction

Gymnopleurus, a dung rolling coprophagous genus of beetle, is widely distributed in Asia, Europe and Africa (Arrow 1931). The fashioning and transportation (by rolling) of dung balls, by these beetles not only reduces congestion at the resource site but could also give the rollers a competitive edge over the dung burying groups like the Coprini, Onthophagini, Onitini, etc., which compete for food and burial space beneath and around each dung pat (Halffter and Matthews 1966).

It was Fabre (1897), the famed french naturalist, who made the first systematic studies of the three dung rolling genera *Scarabaeus, Gymnopleurus* and *Sisyphus.* Subsequently, several studies on the ball making, rolling and burial behaviour of *Gymnopleurus* have been made (Hingston 1923, Honda 1927, Prasse 1957a, 1957b, 1957c, 1958a and 1958b).

In India, however, after Hingston (1923), the behaviour of these beetles (in particular *Gymnopleurus*), has gone largely unnoticed. A study on the field behaviour of two commonly occurring species of *Gymnopleurus*, namely *G. miliaris* and *G. gemmatus* was therefore undertaken.

Material and Methods

The feeding and breeding behaviour of *G. miliaris* and *G. gemmatus* were studied in grazing fields at two locations (Hebbal and Allalsandra) on the outskirts of Bangalore (12° N lat. and 77° E long., 916 m alt.) in S. India. The study sites are situated at about 7 and 11 km north of Bangalore, respectively. The rainy season which commences here in late April continues till the end of September during which period these beetles are active. During the period of study (1984-1986) the mean maximum and mean minimum temperatures were 29.8° C and 18.2° C while the total annual rainfall amounted to 548.3 mm.

Observations were made on the following elements of beetle behaviour, namely a) approaching food, b) feeding, c) ball making, d) ball rolling, e) mating, f) intra- and inter-specific competition, and g) kleptoparasitism.

The rollers, *G. miliaris* and *G. gemmatus* were identified by Dr. R. Madge of the British Museum (Natural History), London.

Results and Discussion

The beetles commenced activity after the first rains in late April. They are diurnal, with their period of activity usually extending from 0700 to 1830 hrs. Light showers did not make them cease activity.

Approach to food: The beetles always located

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their food by flying low, in a zigzag manner and alighting at a mean distance of 8.65 cm (*G. gemmatus*) and 8.85 cm (*G. miliaris*) from the food source. Whenever they landed on their backs they used their mid pair of legs as pivots to right themselves. A few alighted directly on the dung pat. Having detected the presence of food, the beetles, with antennae waving feverishly, walked briskly towards it. On reaching the food source, they walked all over it to finally select a suitable spot to commence feeding.

Feeding: Both the species of *Gymnopleurus* were attracted to human faeces, sheep excrement and cow dung. It was visually apparent that the beetles preferred human faeces of the three sources of excrement.

The beetles commenced feeding at the dropping after having selected a suitable spot on the dung mass. When feeding on sheep-pellets, it was noticed that the beetles fed exclusively in the inner core by boring into the pellet. This brief period of feeding was followed by ball making.

Balls of excrement were fashioned for various purposes, namely i) for food, ii) as nuptial gifts, and iii) for rearing brood.

Both the species of *Gymnopleurus* made food balls, rolled, buried and fed on them unlike *G. mopsus* Pallas and *G. geoffroyi* Fuessly (Prasse 1957a, 1957b, 1958a) which never made any food balls. Hingston (1923) also reports food ball preparation in *G. miliaris*.

Prasse (1957a) has reported that species of *Gymnopleurus* undergo a 'Reifungsfrass' period of 3-3.5 months. In the present study the beetles which emerged with the onset of the rains were found mating on the first day and brood balls were made a week after. So the Reifungsfrass period is definitely shorter for these two species of *Gymnopleurus*.

Ball making: After selecting a suitable spot on the faecal mass the beetles carved out circular segments of dung from the rest of the mass using their front tibiae and clypeus. During the process of fashioning, bits of dung were added from the main mass whenever the initial mass was found to be inadequate.

The sphere was finally detached from the main mass by the beetle moving down the side of the ball to its point of attachment at the base. The beetle then pushed against the ball with its middle and hind pairs of legs till the ball got detached. It was then rolled to the edge of the pat.

Perched on the ball they patted it into a smooth sphere using their fore tibiae. Once again, any deficiency in the quantum of dung making up the sphere was made up by adding from the main mass and if in excess, the extra material was cut away with the clypeus and discarded. Each beetle took about 11.07 ± 1.03 min. (*G. gemmatus*) and 10.10 ± 1.23 min. (*G. miliaris*) to construct and fashion one ball. In those cases where the partner was chosen during the period of ball construction, the new partner also helped in ball making.

When sheep pellets were used as raw material for making balls, a different technique was adopted. The beetles then broke open a number of sheep pellets to collect sufficient material from the soft inner core. These were then used sequentially in the fashioning of a ball of requisite proportions.

Ball making was observed at temperatures between 23.3°C and 29.4°C.

Ball rolling: The ball of dung once detached was rolled away from the dung pat to a distance of about 10-20 cm, where the beetle was generally noticed to finally shape the ball. Sitting on the ball, the beetle patted the ball into shape using its forelegs, as well as by intermittently pressing the ball with its clypeus. On completion of this final fashioning of the ball into a compact spheroid the beetle began rolling the ball. The average diameter and weight of the balls rolled by a lone beetle was 1.0 ± 0.13 cm and 0.34 ± 0.11 g (*G. gemmatus*), 1.03 ± 0.1 cm and 0.36 ± 0.09 g (*G. miliaris*). On the other hand, when pairs rolled the ball, it was 11.15 ± 0.11 cm and 0.36 ± 0.06 g (*G. gemmatus*), 1.13 ± 0.31 cm and 0.48 ± 0.03 g (*G. miliaris*).

As the ball was rolled along, it acquired a thin coating of soil. If a single beetle was engaged in rolling, it pushed the ball with its middle and hind pairs of legs while it had its forelegs on the ground. In 90% of the cases it was the male that made the ball; to be later joined by the female. As Thornhill (1983) suggests, the "material benefits" — here the dung ball — are provided by males probably to reduce the loss of energy in the female in making a ball as she has to spend a lot of energy on other activities like — rolling, burying and brood ball making, egg laying, etc.

However, it was noticed that the maker of the ball, irrespective of its sex, did not readily accept as a partner the first individual that came up to the ball. If a male was the ball maker it fought and chased away all approaching males; while it accepted an approaching female, only after a brief combat of about 15-20 seconds. If the ball maker was a female it too chased away all females but accepted a male after a brief combat. To ascertain the sexual identity of each rolling pair, over 50 pairs of both *G. gemmatus* and *G. miliaris* were dissected. Almost every pair, it was found, consisted of a male and a female. In only two instances members of the same sex were found rolling the ball.

This was the result of intra-sexual combat in which individuals of the same sex fought each other in a bid to steal and gain possession of the ball. In fact, females of both the species were rolling a ball. This behaviour has been reported earlier for *Scarabaeus sacer* (Fabre 1897) and *G. miliaris* (Hingston 1923). In transporting the ball, males and females took up characteristic stances in all cases. The female always stood behind the ball, pushing with the last two pairs of legs, while the male pulled the ball from the front using its last two pairs of legs.

This contradicts Hingston's (1923) observation that 'as a rule' the male pushes the ball while the female pulls it. Observations similar to that in the present study were made by Honda (1927) for *G. sinuatus* (Ol.) and Prasse (1957b, 1958a) for *G. mopsus* and *G. geoffroyi.*

During the course of rolling the male was unable to keep pace with the female. He would tumble off but the female would continue rolling, apparently unconcerned, while the male hastened to catch up. On the other hand, in cases where the female fell, the male waited with the ball for her to rejoin him. He would permit her to resume her role only after a short skirmish lasting 2 to 3 seconds. If, for some reason, the female failed to return, the male abandoned the ball after a period of waiting. In one instance the male waited for 3 min. 40 sec. and in another for 5 min. during which time they met new females with whom they continued the activity of rolling. Unlike males the females continued rolling the ball and buried it even when the males had deserted.

In some cases, the male was found sitting on the side of the ball instead of pulling it, which contradicts Hingston's (1923) report that this is found only in *Scarabaeus sacer* and never in *G. miliaris.* Nevertheless Prasse (1957b) has reported the same for the two species of *Gymnopleurus.* In such cases the male would get off the ball when the female needed help in surmounting an obstacle.

The beetles never rolled the ball in a straight line. Most were found rolling the ball in a haphazard manner, sometimes crossing the same spot several times and finally burying their balls close to the starting point, even though the balls were rolled for much greater distances than the shortest distance between the food source and the burial site. This once again contradicts Hingston's (1923) observations that the pellets must be rolled strictly in straight lines.

Whenever the beetles encountered an obstacle they adopted any one of the following three strategies. i) crossed over the obstacle, ii) took a detour, or iii) buried the ball at the base of the obstacle.

The average distance rolled by a pair of beetles was 11.71 m, n = 15 (*G. gemmatus*) and 22.22 m, n=15 (*G. miliaris*). The average distance rolled per minute was 105.10 cm, n=15 (*G. gemmatus*) and 119.53 cm, n = 15 (*G. miliaris*). When a single beetle rolled a ball it often stopped rolling, climbed on the ball, checked all around the ball and got back into position to continue rolling the ball. On the other hand when a pair were engaged in ball rolling, the female stopped periodically to inspect the surface of the ball. On encountering the male on the other side she often tried to butt him off, only to recognize him later and then continue rolling. The average time taken for rolling was 16 min., n = 10 (*G. gemmatus*) and 20 min., n = 10 (*G. miliaris*).

Ball burying: In burying the ball, individuals and pairs adopted different strategies. In the case of pairs, it was always the female who selected the burial spot. She walked away from the ball, examined a certain area and then returned. When individual beetles were involved, they tested and selected sites while holding onto the balls with their hind legs.

Selecting a suitable burial site involved the prior rejection of a number of sites. Four such rejected sites were examined by digging. Strangely, the kleptoparasites *Onthophagus pygmaeus* (Schall.) and *O. centricornis* (F.) were found to be present beneath the soil surface.

When single beetles buried balls they came out of their pits several times during the process of digging to check for the presence of the ball. Having made a small pit, the beetle dragged the ball into the pit and disappeared beneath it to continue digging as a result of which the ball disappeared into the soil.

In case of pairs, it was always the female which took to digging while the male stood guard. After making a small pit, she rolled the ball with her hind pair of legs. Sometimes the male helped her in pushing the ball into the pit. During the period of burying the male either sat on the ball or walked around the pit. Sometimes he held the ball with his front two pairs of legs while he stood at the rim of the pit. When 75% of the ball disappeared into the soil, the male also entered the soil to join the female. The average time required for burying the ball was 14.36 ± 4.06 min., n = 10 (*G. gemmatus*) and 13.45 ± 2.08 min., n = 15 (*G. miliaris*).

Digging up twenty marked burial sites after a day or two revealed the following.

1. During the early part of the season, most of the lone beetles used the balls for feeding and only frass and faecal matter were found in the burrow.

2. Later in the season, lone females used the ball for raising brood.

3. Balls rolled by the pairs used them both for enticement and raising brood.

Mating: Both species generally mated in the space between the side of the dung ball and the pit and sometimes above the ball when it had fully descended into the pit. The male then clasped the female in the copulatory position, and kept strumming on the female's elytra with its forelegs. The frequency of strumming increased whenever other insects moved in the vicinity. The female generally fed on the dung ball while engaged in mating, while at times she stood still doing nothing. On completing mating which took about 13 min., n = 4 (*G. gemmatus*) and 19 min. 30 sec., n = 5 (*G. miliaris*), the male stayed with the female for a further 4-5 sec., after which time it either flew away or stayed on to guard the female when he suspected the presence of other males. The female continued digging beneath the dung ball. Some pairs of beetles (3 of *G. miliaris* and 2 of *G. gemmatus*) were seen mating even before the pit was dug, such beetles abandoned the ball and flew away.

Occasionally males were found trying to mate on the dung pat, but were not successful.

Brood ball construction: After mating, the female proceeded to make a slanting tunnel which terminated in a brood chamber. The ball was torn apart and refashioned into a pear shaped ball. An egg was laid in the egg chamber constructed at the top end of this fashioned brood ball. The ball rested on its broad end in a pear shaped brood chamber located at an average depth, of 5.1 cm (*G. gemmatus*) and 7.5 cm (*G. miliaris*). The average length and breadth of the brood balls of *G. miliaris* and *G. gemmatus* were 1.45 ± 0.23 cm and 1.2 ± 0.18 cm (n = 12); and 1.34 ± 0.31 cm and 1.1 ± 0.08 cm (n = 10), respectively. Their respective weights were 1.12 ± 0.2 g (n = 12) and 0.99 ± 0.18 g (n = 10).

Competition: Both the species of *Gymnopleurus* under review exhibited inter- and intra-specific competition.

Intra-specific competition: There was intense competition among the males to gain possession of ready made dung balls. This was observed from the very first day of activity.

Ball rolling males had to repeatedly fend off males that challenged the right to ownership of their ball. On sensing the arrival of a rival, the owner stood on the ball with its head towards the ground. The strategy of the rival male was always to move around the ball trying to get a foot hold. The owner of the ball would keep moving on the ball so that the rival was always on the ground without access to the ball. If the rival came too close, the owner tossed it away using its clypeus. But if the rival managed to out manouvre the owner and get atop the ball, then it in turn would toss the owner away.

Whenever a rolling pair was challenged by the arrival of a rival male it was only the male that fought him while the female remained passive. They butt and toss each other in combat. If the period of waiting was too long the female abandoned the fighting males with the ball, in search of a new partner.

Whenever a pair of rollers were rolling a ball, they were followed by males of their own species as well as other species. The males followed the ball either by walking or flying. Whenever the pair stopped rolling, the male that was following behind hid under grass or leaves in the vicinity. In this way, males followed the ball till the pair started burying the ball. Then the males in hiding attempted to reach the digging female, but retreated whenever the 'owner' male noticed and chased them. It was also observed that when the owner male succeeded in getting at the smaller intruder males, he sat atop them and started drumming on them with his clypeus and forelegs after which the looser ran away and took cover in the grass.

It was also noticed that whenever a male sitting and waiting on a ball, saw another male sitting or rolling a ball nearby it immediately chased the other male and took possession of that ball. In one such case a male took poosession of new balls on three successive occasions.

Competition was seen even after the ball was buried. Males of *G. miliaris* and *G. gemmatus* were seen landing and walking straight into mounds of soil where pairs of *G. miliaris* and *G. gemmatus* were found with dung balls. Males of one species sneaked into the burrows of other species.

Interspecific combat: Various species of *Onthophagus* and *Caccobius* also compete for access to dung balls in addition to the competition that has been noticed between the two species of the *Gymnopleurus* under study. Three species of *Onthophagus*, namely *O. centricornis. O. pygmaeus* and *O. ludio* Bouc. and one species of *Caccobius*, namely *C. meridionalis* Bouc., tried repeatedly to gain entry into the brood balls of both *G. miliaris* and *G. gemmatus*.

Competition was noticed between the males of *G. miliaris* and *G. gemmatus* for the balls, and was similar to that explained in intraspecific competition. In one instance combat was observed between two females of *Gymnopleurus* spp. for the ball. The ball was pulled out by *G. gemmatus* and during the process of combat the ball was being rolled along.

The presence of kleptoparasites was noticed right from the ball construction stage to even after the egg had been laid in the brood ball. But they proved to be more persistent attackers once the beetles commenced rolling the balls. The kleptoparasites followed the rolling pairs on the wing, alighted in the vicinity of the ball and sought a hasty entry into it whenever the pairs paused for some reason. One pair of *G. miliaris* that was observed, had to face attacks from *G. gemmatus* (once), *O. centricornis* (eleven times), *O. pygmaeus* (four times) and *O. ludio* (once), while having to traverse a distance of 17.10 m.

If detected the *Gymnopleurus* spp. butted and tossed away the sneaking kleptoparasitic species. Even those kleptoparasites that had managed to enter the ball unnoticed were detected in a short while and extricated from the ball after it had been pried open by *Gymnopleurus*. Along with the kleptoparasite a small amount of dung was lost. The ball was then refashioned once more and the process of rolling continued.

It was also noticed that those males with the ball abandoned by the female never extricated the kleptoparasites when they entered the ball but flew away abandoning them.

The kleptoparasites that escape detection convert the brood balls of *Gymnopleurus* into brood masses for their own off-spring, *O. centricornis* was observed to have made four brood masses out of one brood ball in one instance. In two other cases they had converted it into 2 or 3 brood masses. In the latter case the brood masses weighed 160, 110 and 118 mg.

Predation: Analysis of the stomach contents of the garden lizard *Calotes* sp. revealed fragments of *Gymnopleurus*.

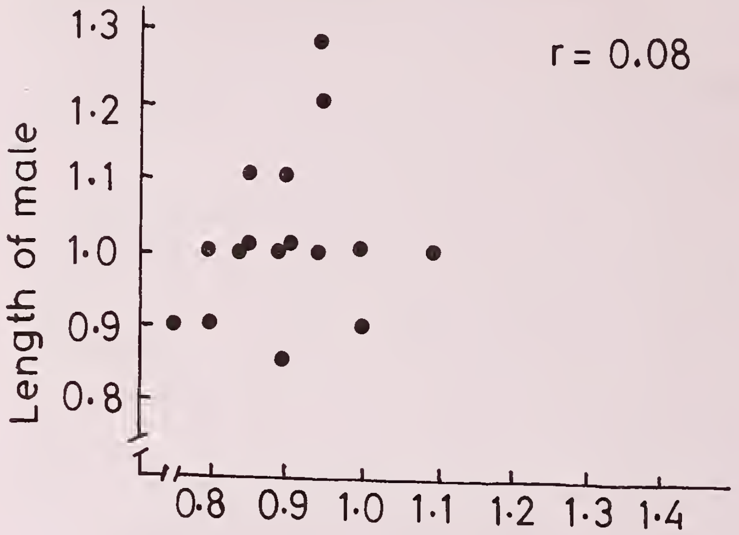
Ants of the genus *Camponotus* were also found attacking ball rolling individuals of *G. gemmatus*. When attacked, the beetles abandoned the balls and flew away.

G. gemmatus and *G. miliaris* invest a considerable quantum of their time and energy in the fashioning (11.08 ± 1.36 min., 10.40 ± 1.14 min. respectively) and burial (14.36 ± 3.66 min.; 13.45 ± 2.8 min. respectively) of dung balls. The evolution of this behaviour not only enables these species, like the other dung rollers, to rapidly acquire the necessary resources in ball form, but it also provides the females ample opportunity to choose a more fit male. Hence, while giving these species an edge in the competition for food and burial space over the other burying groups like the Coprini, Onthophagini, etc., which are competing beneath or around each dung pat (Halffter and Matthews 1966) this behaviour simultaneously ensures rigorous epigamic selection (Huxley 1938). However, the greater amount of time spent on the surface of the ground while rolling exposes these beetles to the hazards of parasitism and predation.

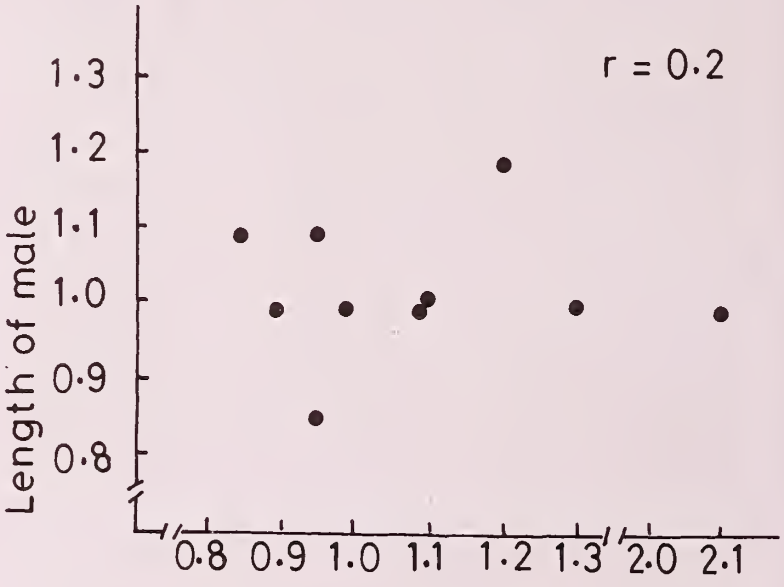
Observations made during the current study indicate that while pre-mating female choice does occur in both the species, female choice during and after mating are also possible.

Pre-mating female choice occurs during the three stages of fashioning, transportation and burial of the ball.

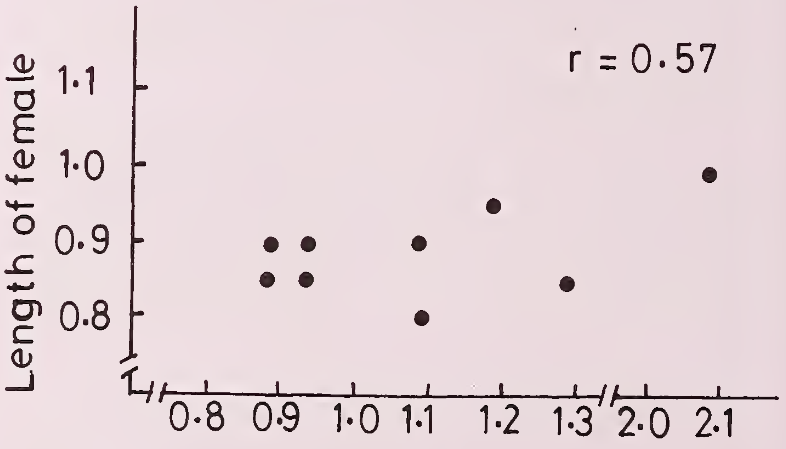
i. **Ball fashioning**: To increase their reproductive success by attracting females, males of *G. miliaris* and *G. gemmatus* have to fashion relatively larger balls of excrement. As there is very low correlation between the size of the male and the size of the female (r=0.08) the female does not seem to be choosing males. The weak correlation between the male size and ball size indicates that large individual size does not necessarily result in large ball size (r=0.2). All this combined with the fact that female size and ball size are relatively highly correlated (r=0.57) points to the possibility of cryptic female choice (Fig. 1).



(a) Length of female



(b) Diameter of the ball



(C) Diameter of ball

Fig. 1. Relationship between length (cm) of (a) male and female; (b) male and dung ball (dia.); (c) female and dung ball (dia.) in *G. miliaris*.

Instead of choosing the larger males (r=0.08) females are choosing larger balls (r=0.57).

ii) **Ball transportation**: Having initially chosen a male capable of making a larger ball, the female further assesses male capability/fitness by:

a) watching how soon the male she has chosen can ward off the intruder males; b) choosing the winning male in the event of a skirmish. Males which take either too long to win a fight or are ousted in battle are abandoned by the females.

iii) **Ball burial**: In this phase males face the danger of losing females to other competing males or to having their effort wasted by intruding kleptoparasites which occupy the dung balls and destroy the eggs of *Gymnopleurus*. Intraspecific male competition is thus intense during these phases.

iv) **Mating**: During mating the female can exercise mate choice by regulating the mating duration. However, since the number of mating individuals observed during the study was small (n = 4 for *G. gemmatus,* for *G. miliaris* n = 5) no definite conclusions could be arrived at in this regard (cv for *G. gemmatus* was 16.6, while for *G. miliaris* it was 21.7).

v) **Post-mating**: The female makes her final choice of the male by deciding whether to mate again or not. Having mated once, females have been observed to mate again. The presence of a horseshoe shaped spermatheca also points to the distinct possibility of sperm precedence (Halffter and Edmonds 1982) as the sperm of the last mated male is most likely to fertilize the ova in spermatheca shaped thus. This could be the reason for the male to follow rolling bisexual pairs, waiting for an opportunity to be the final one to copulate with a female before she lays eggs.

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NOTES ON LONG-EARED HEDGEHOG *HEMIECHINUS AURITUS* (GMELIN)[1]

SATISH KUMAR SHARMA[2]

(*With a text-figure*)

Key Words: hedgehog, sex ratio, body-weight, nurseries, litter-size

The Long-eared Hedgehog *Hemiechinus auritus* (Gmelin) is a nocturnal mammal found in the arid and semi-arid areas of Rajasthan. A study was conducted at World Forestry Arboretum, Jaipur, on the biology and behaviour of *H. Auritus* between June 1989 and June 1991. Male-female sex ratio in adults was nearly 1:1. The mean weight of the adult females (306.2 gms) was slightly more than that of adult males (256.6 gms). Their breeding coincided with the rainy season and the Young are born in burrows. Litter size varies from 1-2. The female alone takes care of the young. The young are born blind and without spines. Later the mother escorts her babies during night rounds. The young become independent before commencement of summer. Hedgehogs are destroyed in various ways in Rajasthan. We can save them only by creating awareness among the public.

INTRODUCTION

The Long-eared Hedgehog *Hemiechinus auritus* (Gmelin) is a nocturnal spiny small mammal, widely distributed and known in the state of Rajasthan by vernacular names such as 'Jhaoo-chuha', 'Jhaoo-musa', 'Jhaoo', 'Jhawla', 'Bhuinthda', 'Dhuan-dhuan', 'Gaoo-ghota', etc. It is mostly confined to arid and semi-arid portions of the state. Very little is known about the breeding biology and other habits of this animal. In this paper, these aspects of this species are described.

STUDY AREA

The present study was mainly conducted at the World Forestry Arboretum (Part A), Jaipur, confined to an area of 1.45 sq. km. The arboretum is situated on the outskirts of Jaipur city between National Highway (Bye Pass) No. 8 and Jhalana hills.

This place receives an annual rainfall of 548 mm. The maximum rainfall is received during July and August. The average relative humidity is 58.6 percent. The temperature ranges from 2° C to 44° C (av. 23°C). Eastern part of the arboretum is hilly but aeolian (soil transported by wind) sand deposit is confined to the foothill zone with *Leptadenia pyrotechnica, Calotropis procera, Saccharum bengalense, Mytenus emarginata,* etc. The sandy tract of the arboretum provides an ideal habitat to the Long-eared Hedgehog.

MATERIALS AND METHODS

Observations were taken from June 1989 to June 1991. Long-eared Hedgehogs were captured during night time. Two of our night-watchmen rendered their services for the purpose. From July to October, intensive night surveys were made to capture the animals. All the captured animals were sexed, marked and freed after weighing. To give a particular code number, tips of spines of cephalic and lumber regions were cut using scissors. Each year a fresh marking was practiced.

Pit digging and planting are two major operations in the forest areas during rainy season. While doing these operations in the arboretum, all the officials and labourers were requested to note and inform about nurseries of Long-eared Hedgehogs, when encountered.

Foraging individuals were captured after dusk and before dawn. No animal was found naturally wandering in the day time. Bagged animals were weighed on a portable dial balance in the field to avoid any loss in body weight of animals due to exertion and starvation.

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RESULTS

Breeding: Data on animals caught are given in Table 1. It suggests that the breeding period of the animal coincides with the rainy season, i.e. June to September. It can also be concluded from Table 1 that during winters, to escape severe cold, the animals probably hibernate. During the months of October and November, when cold is not severe, few wandering animals were observed in the night; but, from December to February, which are the severest months of the winter, not a single animal was observed in the field. This suggests that they probably hibernate, become lethargic during the severely cold months. Prater (1980) has suggested this possibility. It can also be deduced from Table 1 that 1 to 2 young are found in a litter. Interestingly the litter size is very small in comparison to the five pairs of teats present. Early infant mortality may be one of the reasons, for the recorded litter size.

At the time of birth, the young are blind and lack spines. During infancy, babies have flexible spines on their dorsal and lateral sides. As the young grows, the spines stiffen. Initially a fairly good number of spines seemed white in colour but gradually became shiny black. Except light coloured whiskers on snout, the head, chin, throat, limbs, ears and ventral side generally lacked hairs. The bare skin of these parts are pinkish in colour. Pinnae were proportionally smaller in infants. As they grow, size and erectness increases in pinnae and a fold develops on lower edge of each pinna at adulthood. When 'ball' formation takes place, this fold helps the animal to adjust the long ears in the minimum of space.

Though adult individuals have a pointed pig-like snout, the newly born do not have this character. Their snouts are almost blunt having roughly equal sized upper and lower jaws while in adults the upper jaw projects far beyond the lower jaw. The blunt snout of the baby hedgehog could be an adaptation for suckling. As the young grows, the snout gradually tapers and ultimately becomes pointed in adulthood.

Parental Care: The young are born in burrows. It was general observation shows that wherever the nursery of a female was disturbed, it abandoned its burrow with its new born as early as possible. The young are transported by the mother at night only. She carries them by gripping the loose skin of the side of neck or body (Fig. 1).

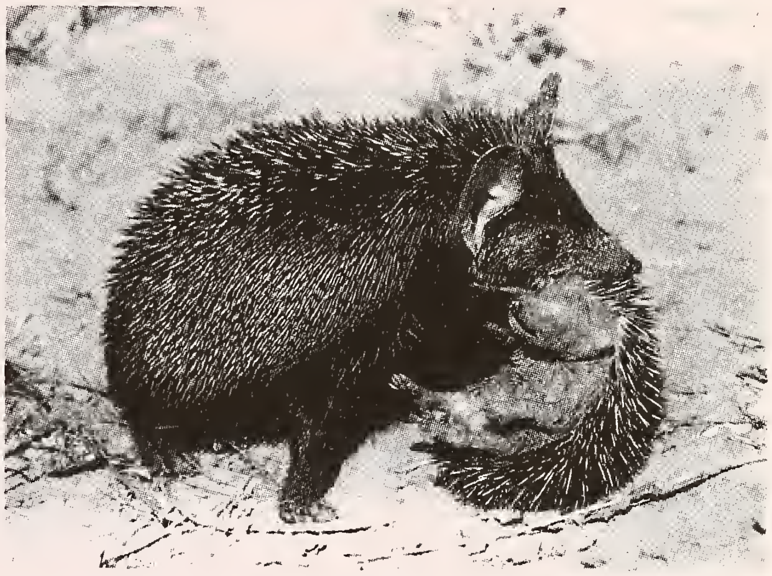

Fig. 1. A female Hedgehog transporting her young.

When the young are separated from their mothers, they make a shrill sound. When a foraging mother returns to her burrow and senses something unusual (like the presence of an observer in a hide near the burrow) she may wait among the thickets till she is assured that there is no danger near the burrow. She may even remain away from her young for a whole day and a night or even more, as is evident by the behaviour of the female C-6-1990. The activities of the female are given in Table 2.

During September 1990, an adult female and two small sized young were found run over in the morning on the bye-pass road bordering the arboretum. They had been run over during the night and their bodies had became flat. All the carcasses were roughly in a straight line, parallel to the road. Heads of all the three individuals were facing south. Interestingly, corpses of both the young ones were behind the mother. All three dead animals were confined to a 40 cm x 20 cm area. An almost similar incidence was observed in October 1990. These observations led to the assumption that after the eyes are open, the young hedgehogs follow the mother at

TABLE 1

MONTH-WISE DATA ON LONG-EARED HEDGEHOGS IN WORLD FORESTRY ARBORETUM, JAIPUR.

Season	No. of animals captured							No. of individuals					
	in field while wandering in night					in burrows		found dead in water tanks*			found run over on road		
	Solitary adult male	Solitary adult female	Female with young		Solitary young	No. (mother+ young)	frequency	Adult male	Adult female	Solitary young	Solitary male	female with youngs	
			No. (Mother+ young)	Fre-quency							No.	(mother+ young)	Fre-qency
Rains (June 1989 to Oct. 1989)	4	1	1+2	1	—	1+2 1+1	1 1	—	—	—	—	—	—
Winters (Nov. 1989 to Feb. 1990)	—	—	—	—	—	—	—	—	—	—	—	—	—
Summers (March 1990 to May 1990)	2	1	—	—	—	—	—	—	—	—	—	—	—
Rains (June. 1990 to Oct. 1990)	7	—	1+2 1+1	1 1	—	1+2 1+1	3 1	1	1	—	1	1+2	2
Winters (Nov. 1990 to Feb. 1991)	2	3	1+1	1	3	—	—	1	—	1	—	—	—
Summers (March 1991 to May 1991)	3	2	—	—	—	—	—	—	—	—	—	—	—
Total	18	7	4+6	—	3	6+10	—	2	1	1	1	2+4	—

*Animals found dead in different tanks on different dates. (Sex of adults only have taken into consideration).

TABLE 2
DEPARTURE AND RETURN TIMINGS OF DISTURBED FEMALE HEDGEHOG C-6-1990

Date	Time of departure from burrow (hrs)	Time of return to burrow (hrs)	Time of stay in burrow (minutes)	Time of stay outside burrow (minutes)	Observations
14.9.90	1905	2031	--	86	--
	2035	--	4	--	Carried one young.
15.9.90	--	--	--	--	Not returned to burrow at all.
16.9.90	--	0615	--	2020	--
	0618	--	3	--	Carried another young.

night. During night surveys 'Caravans' of Hedgehog families captured in groups of 1+1 or 1+2, with the mother leading the juveniles, substantiates this fact (Table 1).

During November 1990, three solitary young of the current year were captured wandering at night. One solitary young was also found dead in a water tank. Before June and after December no female was captured with young. These observations suggested that the young hedgehogs become independent before the summer of the same year.

Sex ratio and body weight: A total of 35 adults and 13 young ones were weighed in the field. The mean weight of adult females (306.2 gm, n=17) was slightly more than that of adult males (256.6 gm, n=18). The adult sex ratio was nearly equal. The blind young ones about to open the eyes in burrows weighed only about 60.1 gm (n=10) while the independent young hedgehogs weighed 125.2 gm (n=3)

Destruction of hedgehogs: A considerable number of Long-eared Hedgehogs are destroyed in Rajasthan every year. It is believed by rural people that hedgehogs are rat-destroying animals, hence they are transported to houses from fields. Due to their removal from the fields, many mothers get separated from their new born. It is obvious that the young cannot survive without their mothers. Similarly, there is a practice among rural people to fumigate the Cucurbitaceous climbers, like *Luffa acutangula, L. cylindrica, Benincasa hispida*, etc., by burning the skin and spines of Hedgehogs to induce heavy fruiting. Hedgehogs are killed for medicinal purposes also. During epidemics of foot and mouth disease of cattle, it is a general practice in many parts of Rajasthan, specially in the southern part, to bury a live hedgehog in a pit in front of each house. Cattle are then passed over the pit.

During nights, wandering Hedgehogs may stumble in wells and tanks that are without parapet walls (Sharma 1993). Many are runover by vehicles (Sharma 1988, 1992).

Conservation measures: Hedgehogs play an important role in destruction of insects and even rats and mice (Sinha and Ray 1983), hence they should be protected. A considerable number of hedgehogs are killed in rural areas. "Gram-Sewak" — an 'agricultural guide' in rural areas can educate farmers and agricultural labourers by teaching them about the role played by the hedgehogs and other wild animals in an agro-ecosystem. Agriculturists should be advised not to bring the hedgehogs, specially females, to the home, atleast during breeding season. The children's science books may also have a chapter on these animals which are beneficial to our agriculture.

Raising of parapet walls around wells and tanks on agricultural land avoids the falling of stumbling hedgehogs and other nocturnal animals into them. Vehicle drivers should be careful of animals crossing the roads.

CONCLUSION

It can be concluded from the present study that female hedgehogs are slightly heavier than males. Sex ratio among adults is nearly 1:1. Young ones are given birth in burrows during rainy season when grass cover and plenty of insects are available. Litter size varies from 1 to 2. The female alone takes care of the young ones. If a nursery of a female is disturbed, she transports her young one by one to another safer place during the night. Babies are transported by her by griping the loose skin of the neck or body as members of the Cat family do.

A large number of hedgehogs are destroyed in Rajasthan every year for domestic uses. These animals cannot be saved without creating awareness in public.

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ROOST SELECTION BY INDIAN PEAFOWL (*PAVO CRISTATUS*) IN GIR FOREST, INDIA[1]

Pranav Trivedi[2] and A.J.T. Johnsingh[3]

Key Words: roost, riverine forest, preference index, selection, structure, floristics, predation

A study was carried out on roost selection of Indian peafowl (*Pavo cristatus*) in Gir forest, Gujarat. The results revealed that all the roosts were located in the narrow riverine forest belts. Peafowl selected tall trees growing on steep river banks with thorny undergrowth and climber thickets in the canopy for roosting. This clearly indicates that roost selection is chiefly influenced by the risk of predation from nocturnal mammalian predators such as leopard. Trees of *Pongamia pinnata* and *Holoptelia integrifolia* showed more than expected use. However, it could not be confirmed whether a choice at species level does exist at all. Roost selection appeared to be a hierarchial process with structure at first and floristics at second level affecting the choice.

Introduction

Roost selection is a vital component of the overall habitat selection process. Therefore information on roost selection by a species carries immense importance for assessing its conservation needs. Gadgil and Ali (1975) attempted to explain the communal roosting habits of Indian birds based on the existing hypotheses which include reduced heat loss, information sharing, assessment of population and reduced risk of predation. Though, Indian peafowl (*Pavo cristatus*), a common bird of India is known to roost in the trees at night, no information exists on roost selection by the bird. In a strict sense, it is neither a communal nor a solitary rooster (Trivedi 1993).

This paper attempts to provide information on roost selection by Indian peafowl in a wild landscape. The following results were obtained during a study carried out from November 1992 to April 1993 (Trivedi 1993) on habitat selection by peafowl in Gir forest.

Study Area

The study was carried out in Gir National Park (N.P.) and Sanctuary [(both collectively hereafter referred to as Gir Protected Area (PA)] located in Gujarat, India. Gir PA (1412 sq. km) is the only remaining large, contiguous, forested tract in the Saurashtra peninsula of Gujarat. The PA is covered with tropical dry deciduous forests, thorn forests and riparian forests. The chief floral elements include *Tectona grandis, Diospyros melanoxylon, Wrightia tinctoria, Zizyphus mauritiana, Ficus bengalensis, Morinda tinctoria, Phyllanthus emblica, Bauhinia racemosa, Holoptelia integrifolia, Boswellia serrata* and *Lannea coromandelica.*

The PA is the last stronghold of the Asiatic lion (*Panthera leo persica*) and apart from lion the vertebrate fauna includes leopard (*Panthera pardus*), jackal (*Canis aureus*), jungle cat (*Felis chaus*) and crested hawk eagle (*Spizaetus cirrhatus*) as potential predators of peafowl. Checklist of mammals is available in Spillett (1968). Nearly 250 species of birds have been recorded.

The 'Maldharis' who are local pastoralists and have changed their nomadic lifestyle to a settled one, reside inside the Sanctuary in their settlements called 'ness'. However, N.P. is free from all human activities. Buffalo grazing, tourism, grass harvesting, fireline burning and non-wood forest produce collection are the chief human influences.

Methods

Eight different localities in three study sites (Sasan, Chhodavdi, Dodhi) were surveyed for roost

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TABLE 1
PREFERENCE INDICES FOR SOME PHYSICAL FEATURES OF ROOST TREES USED BY PEAFOWL

Slope category		Distance to water (in m)		Height (in m)		Height of first branch (in m)	
Class	PI	Class	PI	Class	PI	Class	PI
Very steep	1.45	0-25	1.00	0-10	0.08	0-2	0.61
Steep	0.81	26-50	0.87	11-15	3.38	2.1-4	1.73
Gradual	0.90	51-75	1.08	16-20	6.25	4.1-6	2.57
Flat	0.60	76-100	0.73	21-25	8.10	6.1-8	2.69
--	--	>100	0.73	>25	8.09	8.1-10	3.44

PI= Preference Index.

tree use by peafowl. Both, direct and indirect methods were used to locate and identify the roost trees. The former involved walking along the riparian areas during late evening or early morning, to flush the roosting birds and locate the trees. The latter involved searching for droppings below potential roost trees to identify actual roost trees. When a roost tree was located, GBH, height of the first branch, tree height, slope category of the site where the tree was standing (rated qualitatively as very steep, steep, gradual and flat), distance from water (or water body), canopy and understorey characteristics were recorded. The same data were collected on the ten nearest trees from the roost tree to get availability information. In this manner, use and availability of the trees was determined. A widely used method given by Neu *et al.* (1974) was employed for analysing the availability-use information. Preference index (PI) which is expressed as a ratio of per cent usage to per cent availability was calculated for the structural parameters of roost trees.

RESULTS

1034 trees were quantified as described earlier. Of these 128 were roost trees, which reflected the use, and the remaining gave an idea about the availability. All the roosts were located in riparian areas. Roosts were found to be either continuously spread along the riverine areas or located at the confluence of two streams which is normally a steep area.

Structure: There were differences in the use of trees with and without certain structural features. There was a significant difference between the use of trees with and without thickets of climbers in the canopy (x^2= 10.62, df=1, p<0.01). Similarly, there was also a significant difference between the use of trees with and without thorny undergrowth (x^2= 24.61, df=1, p< 0.001). In both the cases, trees with thickets of climbers in the canopy and with thorny undergrowth were used more often for roosting. Preference indices (PI) for various structural features are presented in Table 1. Trees on very steep and steep river banks received a higher usage followed by gentler slopes. Trees growing on flat areas were least used for roosting. All tree height categories above 15 metres were highly used, while category <10 metres was used least. Nearly ninety percent of the trees were within 75 metres from water. Trees with 8-10 m high first branch were used more and the use went in a decreasing order towards 0-2 m height.

Floristics: Twenty one plant species were identified as roosts (Appendix 1) of which twenty were trees and one was *Dendrocalamus strictus* (i.e. bamboo). Table 2 shows the availability and use of

Table 2
ROOST TREE PREFERENCE OF PEAFOWL
[Using Neu *et al.* (1974) technique]

Tree species	Relative availability	Expected use	Observed use	Confidence intervals
Holoptelia integrifolia	0.051	6.554	18	0.058-0.223**
Tectona grandis	0.124	15.846	14	0.035-0.184
Pongamia pinnata	0.198	25.370	41	0.209-0.431**
Syzygium rubicunda	0.131	16.717	13	0.030-0.173
Tamarindus indica	0.181	23.168	6	0.000-0.097*
Diospyros melanoxylon	0.033	4.224	2	0.000-0.045
Others	0.282	36.096	34	0.161-0.371

* Indicates that the species was used less than availability.
** Indicates that the species was used more than availability.
Rest were used in proportion to availability.
($Z=2.6899$, $X^2 = 45.36$)

major roost trees by peafowl. *Holoptelia integrifolia, Tectona grandis, Pongamia pinnata, Syzygium rubicunda, Tamarindus indica* and *Diospyros melanoxylon* were the commonest tree species available and used as roost by peafowl. Rest of the species were in meagre numbers and therefore these were clumped and collectively called 'others' for analysis. Availability-use analysis of these six species and others showed (Table 2) that only *H. integrifolia* and *P. pinnata* were used more than expected; *T. grandis, S. rubicunda, D. Melanoxylon* and others were used in proportion to availability whereas *T. indica* was used less than its availability.

Discussion

The five most striking features of the roost trees selected by peafowl were; they had climber thickets in the canopy, possessed thorny undergrowth, were on steep river banks, were tall and had a higher first branch. All these features indicate that while selecting a roost tree, the most important aspect is of reducing the risk of predation. In Gallinaceous birds, predation is a major population regulatory mechanism (Lack 1954, Hill and Robertson 1988) and therefore it is likely to influence habitat selection significantly. Selection of trees with the above mentioned features is obviously an antipredatory strategy against nocturnal mammalian predators such as leopard and jungle cat which can climb trees and capture peafowl. In Gir, trees with such features are available only in riverine areas and therefore these forests become crucial for peafowl. The location of roosts at the confluence of two streams was due to the fact that this region is steep and therefore predators would find it difficult to approach from below.

It is pertinent to point out that the height of first branch does not seem to be of significance in roost selection. Similarly, distance from water carries secondary importance as all the roosts are located in the riverine area and one hardly finds a roost >100 m from water. However, trees growing right along the bank with overhanging branches above the river provide ideal roosts as birds are safe from the predators due to water. The vital features, therefore appear to be height of the tree, steepness of the bank/ slope on which the tree is situated and the presence of thickets in the undergrowth and in the canopy. It was realized that height alone can be sufficient for selection if the tree is >16 m. But, if it is shorter than that, the other tree features play a crucial role. In a semi-arid and deciduous forest system such as Gir, trees hardly attain a height of over 15 m and therefore it is the presence of thickets and steepness of the slope that should be of significance in the selection process.

Peafowl in semi-urban and rural landscapes often use unusual substrates as roosts, like electric pylons. Palmyra trees (*Borassus flabellifer*) are commonly used in the Southern districts of Tamil Nadu (pers. obs.). This flexibility probably reflects a synergistic effect of the absence of predation pressure and a low availability of good quality roosts.

Interpretation of the data suggests that it is the structure which is the unit of selection at a broader scale, but at a finer scale, the selection can be for species. Any tree which satisfies the structural requirements for avoiding predators should be selected by the birds. Structure undoubtedly appears to be the first step in roost selection process. It is possible that only certain tree species possess the necessary structural features of an ideal roost tree which means the choice can be at the level of species. The situation seems to be one of a hierarchial selection as described by Svardson (1949), Hilden (1965) and Wiens (1985). However, this is just a logical speculation and no experimental evidence is available to test it. Peafowl (Genus *Pavo*) are regarded as the terminal lineages of peacock pheasants (Geist 1977). *Pavo* left their original rain forest habitat and started exploiting the productive forest-water ecotone (Geist 1977). They gradually advanced to human dominated landscape also, but were always tied to riverine habitats. Roosting on riverine trees might have evolved at the time of their dispersal from climax forests to more xeric environments, because in these habitats only riverine forests can provide good quality roosts.

One more important feature which influences roost selection is the occupancy of trees by other species. It was observed on ten occasions that peafowl did not use particular trees (even when these were ideal for roosting) because common langurs (*Presbytis entellus*) were roosting there. This brings in the question of competition between taxa for a crucial resource, as langurs also roost to avoid predation by leopard. Langurs too, like peafowl are distributed along the riverine areas in Gir (Joslin 1973) and they too roost in riverine forest. However, the magnitude of such potential competition might not be significant. Only one roost tree of chicks was identified which was short (*c.* 10 m) and had extensive thorny thickets wrapped around the stem. With the exception of four trees (out of 128), no roost tree was located close to the road presumably to avoid the disturbance caused by the vehicles.

Peafowl along with common langur are important buffer prey which facilitate the niche separation of leopard and lion in the Gir PA (Ravi Chellam 1993). Both the prey species need to be conserved. Both need roost trees in the riparian areas. In Gir, there is hardly any disturbance to the trees in riverine areas, but incidences of repeated fire can destroy the undergrowth thickets substantially thereby reducing the availability of good quality roosts. At present it is safe to conclude that the population of peafowl in Gir does not face any imminent danger. Our data on roost selection can be used to predict and confirm the use of roosts in other such deciduous forest ecosystems in a wild landscape.

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APPENDIX I

LIST OF SPECIES USED FOR ROOSTING BY PEAFOWL

1. *Holoptelia integrifolia*
2. *Tectona grandis*
3. *Pongamia pinnata*
4. *Syzygium rubicunda*
5. *Tamarindus indica*
6. *Diospyros melanoxylon*
7. *Terminalia bellerica*
8. *T. tomentosa*
9. *Manilkara hexandra*
10. *Syzygium cumini*
11. *Ficus glomerata*
12. *F. bengalensis*
13. *Miliusa tomentosa*
14. *Mitragyna parviflora*
15. *Garuga pinnata*
16. *Sterculia urens*
17. *Acacia senegal*
18. *Anogeissus latifolia*
19. *Phoenix sylvestris*
20. *Dendrocalamus strictus*
21. *Sapindus emarginatus*

TAXONOMIC AND NOMENCLATURAL STATUS OF *MYRIONEURON* R.BR. EX HOOK. F. (RUBIACEAE)[1]

D.B. Deb[2]

Key words: plant taxonomy, Rubiaceae, *Myrioneuron*, generic status, nomenclature

Taxonomic and nomenclatural status of *Myrioneuron* R. Br. ex Hook.f. (Rubiaceae) is discussed. The generic status is upheld. Nomenclature is clarified. Lectotypes of the genus and the type species are selected.

Introduction

The genus *Myrioneuron* (Rubiaceae) is not yet included in Index Nominum genericorum (Plantarum). R.C. Bakhuizen (1975: 26, 29) treated *Myrioneuron* R. Br. as synonymous with *Mycetia* Reinw., and those of authors, non R. Br. as synonymous with *Keenania* Hook. f. Van Steenis (1987: 106) treated *Myrioneuron* R. Br. ex Kurz 1870 = ? *Keenania. Myrioneuron* spp. (in Herb.) = *Keenania.* He (1. c.) further included this name as a synonym of *Mycetia.* Robbrecht (1988: 244) treated *Myrioneuron* R. Br. ex Kurz, nomen = *Keenania*?

Diane Bridson of Kew Herbarium (in lit.) drew my attention to the situation on examining some Indian material determined by me as *Myrioneuron nutans.* She further observed "neither Dr. Brummitt, nor I find any problem in accepting *Myrioneuron* R. Br. ex Hook. f. 1873 as valid (assuming *Myrioneuron* R. Br. ex Kurz 1870, nomen)". Dr. Dan H. Nicolson, Nomenclatural Editor, *Taxon,* in response to my letter in this connection, advised me to publish a note.

History of Nomenclature

Nathaniel Wallich, the then Superintendent of the Botanic Garden, Calcutta, in 1828, took to London, all the specimens so far accumulated in CAL and brought out those stored in the East India Company's *India Museum*, London (which was dispersed in 1879), with a view to sort out the specimens and name them. He sought help and assistance from contemporary botanists, who were interested in tropical plants.

"*A numerical list of the dried plants in the East India Company's Museum*" (1832), commonly known as *Wallichian Catalogue (Wall. Cat.)*, more correctly, *Wallich num. List* is the result of that effort. Robert Brown of British Museum named many plants of the Rubiaceae. *Wall. num. List* No. 6225 in page 211, 1832 names *Myrioneuron* R. Br., under which *M. nutans* R. Br. is named for two gatherings: 6225a, collected from Sillet, in 1821, by Francis de Silva and 6225b from Gualpara, Assam, on 27th June, 1808 collected by Buchanan (later Francis) Hamilton. The latter was named by Hamilton as *Bertiera nutans* Ham. in Scheda (nom. nud.)

Robert Brown postulated generic status for *Myrioneuron* to accommodate these two gatherings and used the specific name given by Hamilton on the herbarium specimens, i.e. *Myrioneuron nutans* R. Br. as is evident in *Wall. Num. List* (1. c.). The taxon remained in name only until J.D. Hooker, in Benth. & Hook. f. Gen. p1. 2: 69. 1873 validated the generic name with a description. He did not name any species therein. Art. 37 of ICBN (1988) clearly states that prior to Jan. 1, 1958, for validity of publication of a new genus, it was not essential to name the type species.

Kurz (1877:55) validated *M. nutans* R. Br. with a specific description for the material collected from Chittagong by C.B. Clarke, working as the first Curator of the Herbarium, Royal Botanic Garden, Calcutta, Kurz must have studied the Wallichian specimens of *M. nutans* R. Br. extant in CAL. Citation of R. Br. as the author of the species evidently supports this contention. Thus *M. nutans*

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[1] Accepted June 1994.

[2] Central National Herbarium, Indian Botanic Garden, Howrah, India.

Table I

SIGNIFICANT DIFFERENCES AMONGST THE ALLIED GENERA

	Keenaria Hook. f.	*Mycetia* Reinw.	*Myrioneuron* R.Br. ex. Hook. f.
1.	Subherbaceous shrubs; branches without spongy swollen corky bark.	Shrubs; branches with conspicuous spongy swollen corky bark.	Small shrubs; branches with conspicuous spongy swollen corky bark.
2.	Leaves membranous, without marginal stalked glands.	Leaves membranous, with marginal stalked glands.	Leaves coriaceous or subcoriaceous, without marginal stalked glands.
3.	Stipules somewhat recurved, membranous, entire, without marginal stalked glands.	Stipules rather large, membranous or subcoriaceous, tardily caducous, with marginal stalked glands, sometimes toothed and bifid above.	Stipules large, coriaceous, erect, bifid above, without marginal stalked glands.
4.	Inflorescence in terminal heads. capitate	Inflorescence terminal or axillary paniculate, corymbiform or capitate cymes.	Inflorescence terminal or rarely axillary or corymbose cymes.
5.	Peduncle short.	Peduncle short or long.	Peduncle short, stout.
6.	Flowers sessile, apparently unisexual, heterostylous.	Flowers pedicelled, bisexual, heterostylous, sometimes bi or triformous.	Flowers short pedicelled, bi sexual, not heterostylous.
7.	Bracts and floral parts without stalked glands.	Bracts and floral parts with stalked glands.	Bracts and floral parts without stalked glands.
8.	Calyx lobes 5 or 6, longer than corolla.	Calyx lobes 4-6, longer or shorter than corolla.	Calyx lobes 5, longer than corolla.
9.	Corolla lobes 5.	Corolla lobes 4-6.	Corolla lobes 5-6.
10.	Stamens 5.	Stamens 4-6.	Stamens 5.
11.	Ovary 2-loculed; stigmas 2, ovate.	Ovary 2-6 loculed; stigmas 2, linear.	Ovary 2 loculed; stigmas 2, lanceolate.
12.	Fruit a capsule, 2 loculed, with hard endocarp.	Fruit a berry, fleshy or not; 2 or 5-6 loculed.	Fruit a berry, 2-coccous; cocci horny.

R. Br. ex Kurz (1877) is the validating description of the species which is selected as the lectotype of the genus. *Wall. Num. List* No. 6225a (the left hand specimen) collected by *Francis de Silva* from Sillet, extant in CAL is selected as the lectotype of the species.

Taxonomic status: The genus *Myrioneuron* R. Br. ex Hook. f. is apparently allied to *Keenania* Hook. f. and *Mycetia* Reinw. Characteristics of these 3 allied genera are given below:

Keenania Hook. f. Fl. Brit. Ind. 3: 101. 1880.

Small subherbaceous shrubs. Leaves membranous; stipules somewhat recurved, membranous. Flowers sessile, in terminal solitary shortly peduncled involucrate heads; bracts imbricating, concave, coriaceous, unequal, outer ones orbicular, inner linear-oblong or spathulate; bracteoles in pair, spathulate, coriaceous, equalling the flowers. Flowers unisexual. Hypanthium fleshy, shortly oblong; calyx lobes 5 or 6, imbricate, unequal, erect, oblong or spathulate, coriaceous, concave. Corolla about as long as the calyx lobes; corolla tube inflated, glabrous, with a ring of stiff hairs at the throat; lobes 5, valvate, short, orbicular ovate, apiculate, papillose externally. Stamens 5, epipetalous at the base of broad lobed disc; filaments short; anthers small, linear. Ovary 2-loculed; style short; stigmas 2, flat, ovate; ovules numerous on globose placenta, adnate to the membranous septum. Fruit a capsule with hard endocarp.

Type species: *Keenania modesta* Hook. f.

Distribution: 5 species in India (Chachar, Assam) and SE. Asia.

Mycetia Reinw. in Bl. Bijdr. 986. 1826 & Sylb. Ratisb. 2: 9. 1928. Syn. *Adenosacme* Wall. ex Endl. Gen. 1: 552. 1838.

Shrubs; branches with a conspicuous spongy swollen corky bark. Leaves membranous, stalked glandular at the margin; stipules tardily caducous, oblong or lanceolate, stalked glandular at the margin, sometimes toothed, and bifid above. Flowers pedicelled, bisexual, heterostylous, sometime bi or tri-formous, in axillary or terminal peduncled paniculate or corymbiform, often with stalked glands in floral parts. Hypanthium globose or hemispherical; calyx lobes 4-6, persistent, stalked glandular. Corolla tube cylindric; lobes 4-6, valvate in bud. Stamens 4-6, inserted in the tube at different positions; filaments short; anthers linear-oblong, dorsifixed. Disc annular. Ovary 2 or 3-6 loculed; style slender or thickened above; stigmas 2, linear; ovules numerous on fleshy peltate placenta. Berry globose, white, spongy or not, indehiscent or irregularly dehiscent, 2-6 loculed. Seeds many, minute, angled; testa dotted; endosperm fleshy; embryo minute.

Type species: *Mycetia cauliflora* Reinw.

Distribution: About 25 species, India to S. China, Vietnam, W. Malesia.

Myrioneuron R. Br. ex Hook. f. in Benth. & Hook. f. Gen. Pl. 2:69, 1873.

Shrubs; branches stout, with a conspicuous spongy swollen corky bark. Leaves large, coriaceous or subcoriaceous; stipules large, coriaceous, bifid above. Flowers on short stout peduncle in terminal or rarely axillary capitate or corymbose cymes, erect or nodding; bracts involucrate, rigid, coriaceous; pedicels very short, one bracteolate. Hypanthium ovoid; calyx tube very short, lobes persistent, rigid. Corolla cylindric, 5-toothed, valvate in bud, densely villous inside, shorter than the calyx lobes. Stamens 5, adnate to the corolla tube. Disc cushion like. Ovary 2-locular; style short; stigmas 2, lanceolate, cohering; ovules many on hemispherical placenta. Berry ovoid or globose, dry, sometimes fleshy, 2-coccous; cocci horny, slowly dehiscent. Seeds black, many, minute, angled, flat; testa pitted, albumen fleshy; embryo minute.

Type species: *Myrioneuron nutans* Wall. ex Kurz

Distribution: 3 species in E. India, Bangladesh (Chittagong) and Myanmar.

DISCUSSION AND CONCLUSION

Keenania Hook. f. was described as a monotypic genus on the basis of a gathering by R.L. Keenan from Duarbund, Cachar, Assam. The type specimen of the type species *Keenania modesta* Hook. f. of the genus was based on a specimen with sterile anthers and it did not have any fruit. This species has never been recollected. Species described under this genus subsequently from SE. Asia have flowers apparently heterostylous, and the heterostyly is probably combined with dioecism (Bremekamp 1947: 191). The fruit is a two-loculed capsule with hard endocarp; flowers are sessile, apparently unisexual and heterostylous; the inflorescence is in terminal heads; leaves, stipules, bracts and calyx lobes are without stalked glands; branches are without spongy swollen corky bark. These characteristics keep this genus distinct from others.

The genus *Mycetia* Reinw. with about 25 species is more widely distributed. The ranges of vegetative and reproductive characters are much more variable than those in the other two. Leaves, stipules, bracts and calyx lobes are with stalked glands at margins; the inflorescence is terminal or axillary paniculate corymbiform or capitate cymes; flowers are bisexual, heterostylous; the fruit is fleshy or not, 2 or 5-6-loculed. These characters distinguish *Mycetia* Reinw. from others.

Short pedicelled bisexual, isostylous flowers, 2 coccous fruits with horny cocci; bifid stipules; leaves, stipules, bracts, calyx lobes, etc., without marginal stalked glands, etc., distinguish *Myrioneuron* R. Br. ex Hook. f. from the other two.

In the branches with a conspicuous spongy swollen corky bark and in the ranges of vegetative and reproductive characters sometimes extending to such an extent that it appears that *Mycetia* is more akin to *Myrioneuron* and farther away from *Keenania*.

Myrioneuron R. Brown ex J.D. Hooker in Benth. & Hook. f., Gen. Pl. 2: 69. 1873 (T. non designatus).

Myrioneuron R. Brown, *nom.nud.*, in Wallich, Num. List 211, No. 6225. 1832; Steud., nom. 2: 174. 1841; Walp., Rep. 2: 525. 1843; Endl., Gen. 566. 1838; Lindl., veg. Kingdom 765. 1847 (g. Cinchonaceae). *Lectotype* selected here: *M. nutans* R. Brown ex Kurz.

M. nutans R. Brown ex Kurz, For. Fl. Brit. Burma 2: 55. 1877. Lectotype selected here: Sillet, 1821, *Francis de Silva s.n.* ex Wallich, Num. List No. 6225a (the left-hand specimen) in CAL is selected here as the lectotype.

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SOME ASPECTS OF BIRD/MAMMAL ASSOCIATIONS: CONTRIBUTIONS FROM THE INDIAN PLAINS AND THE ZIMBABWE PLATEAU[1]

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Key words: bird/mammal association, Indian plains, Zimbabwe plateau

Some species of birds associate with mammals to feed on insects living either near or on them. This paper attempts to quantify the size of these aggregations with mammals and compare them with unassociated birds on the plains of India and the plateau of Zimbabwe. In India four species of bird were observed associating: two of them occurred in larger groups in such associations and preferred cattle to water buffalo. In Zimbabwe in a drought situation, with a much lower density of mammals, a much higher proportion of observed birds were in such associations. Egrets are known to obtain more food in such associations but this is not proved for the other species involved.

Introduction

All organisms need a competitive edge of some sort for survival. One such advantage is feeding associations between birds and mammals which are a common sight in the tropics. Some birds gain significant amounts of food from such associations, e.g. in Africa oxpeckers *Buphagus* spp. are obligate feeders on ticks (Ixodidae) and other ectoparasites and have lost range in southern Africa with the decimation of large mammal populations (Brooke 1984).

Another example of conservation significance concerns the endangered Kirtland's Warbler *Dendroica kirtlandii* in the United States, whose range has recently been invaded by a nest parasite the cowbird *Molothurus ater.* This bird was previously an associate of the American Bison *Bison bison* and has now expanded its range with the arrival of cattle populations in the range of the warbler and now reduces its breeding success by over a half (McFarland 1981, Robisnon and Bolen 1989).

There have been few quantitative studies of such associations and even fewer of a total community. To the best of my knowledge there are none published for India. Hence while travelling around northern India by train mainly through peasant owned farmland between April and August 1982 covering a distance of 3000 km, an attempt was made to record all associating birds and domestic mammals and quantify their associations. No attempt was made to record all Common Mynas *Acridotheres tristis* because they are liable to be overlooked when perched in trees. The superabundance of the House Crow *Corvus splendens* led to my recording all sightings for only a portion of the total distance. Other species recorded associating with domestic mammals were Cattle Egret *Bubulcus ibis* and the Black Drongo *Dicrurus macrocercus.*

A similar study was performed over a number of years in Zimbabwe by vehicle through European farms and peasant occupied communal areas in the late eighties covering a distance of some 5000 km recording all birds associating and their hosts. The birds involved here were mainly Cattle Egrets again and Forktailed Drongo *Dicrurus adsimilis,* which is considered a different species from the Indian bird. There are published studies of Cattle Egret associations in Southern Africa (Blaker 1969, Siegfried 1978), but not of any other species.

Methods

A herd was defined as any group of animals in a finite area seperated by a larger area from other such groups. A bird was regarded as being in association with a mammal if it was within two metres of that mammal regardless of its perch. Where mixed groups of mammals were observed these were divided into species and the corresponding bird species associating with them were recorded. The number of mynas observed on Dal Lake, Kashmir

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in June 1982 were used for the comparisons of the number of birds in association and not associating. Statistical analyses were performed on the results using students t-tests to determine significant differences. The percentage of all birds (excluding mynas for reasons given above) observed associating, out of the total number observed is also presented. An attempt to see if the number of birds in association with a group increased with increasing group size failed because virtually all groups observed were small (less than five animals). Animal and bird masses are taken from Lander (1949) and Ali and Ripley (1968-1974) respectively. These animal masses are probably larger than the peasant owned stock observed here. These have been used as an estimate of the relative size of the animals and birds concerned.

A similar study was done in Zimbabwe travelling between Bulawayo and West Nicholson. Statistics were not performed for this data but otherwise methods were similar except that for drongos the distance required for association was increased even on occasion to the other side of the road as this bird chases flying insects which are flushed by hosts.

RESULTS

Eight types of domestic mammals were observed in bird/mammal associations in India, but of these donkeys, sheep, pigs, camels, and horses contributed only a very small proportion of such associations and are not further discussed. A total of about 650 groups each of cattle and water buffalo and nearly 300 groups of goats, giving a total of between 5000 and 6000 head each, were observed.

Table 1 presents the frequency of bird/mammal associations observed on the plains of India. For each of the three mammals the percentage of groups observed with each avian species is presented. Further, the percentage of each bird (except the myna) observed in such associations is also presented. Table 2 presents the mean number (± the standard deviation) of birds in association with each mammal and those not in such associations are presented. Data are too meagre for such calculations with goats. All these birds are believed to be residents preforming at most local movements in the area. At this time of the year, all four species would be breeding (Ali and Ripley 1968-74): though some species may be represented by nonbreeders for instance the Cattle Egret.

TABLE 1

FREQUENCY OF BIRD/MAMMAL ASSOCIATIONS ON THE PLAINS OF INDIA (EXPRESSED AS THE PERCENTAGE OF GROUPS WITH ASSOCIATING BIRDS AND THE PERCENTAGE OF BIRDS OBSERVED ASSOCIATING OUT OF THE TOTAL NUMBER OF BIRDS OBSERVED)

Bird Species	House Crow	Common Myna	Cattle Egret	Black Drongo
mass	300 gm	110 gm	360 gm	45 gm
cattle (mass 360 kg)	1%	7%	6%	5%
water buffalo (mass 630 kg)	3%	13%	10%	7%
goat (mass 70 kg)	1%	1%	1%	5%
% of birds in association	1%	—	16%	20%

The number of Common Mynas in mammal associations is significantly larger than those not in such associations (t= 2.812, $p<0.05$). This assumes that flock sizes in Kashmir (altitude 2000 m) are the same as those on the plains. The number of egrets associating and not associating is not significantly different; but the numbers associating with cattle is significantly larger than those associating with water buffalo (t= 1.813, $p<0.05$). Black Drongos, which are the smallest of the four avian species considered here, is the only one not to show a lower association with the goat groups. The number of drongos in associations is significantly larger than the number of those not in such associations (t=2.116, $p<0.05$). All species show a preference for the heaviest animal (water buffalo) in terms of the number of groups

TABLE 2

NUMBERS (MEANS ± STANDARD DEVIATIONS) OF BIRDS WITH AND AWAY FROM HOSTS ON THE PLAINS OF INDIA

	House Crow	Common Myna	Cattle Egret	Black Drongo
Water buffalo	1.1±0.7	1.6±0.6	1.5±0.1	1.4±0.8
cattle	1.3±0.4	1.6±0.9	3.5±2.4	1.1±0.4
total bird/mammal	1.4±0.9	1.6±0.9	—	1.3 ±0.6
away from mammals	1.2±0.6	1.3±0.5	4.6±2.1	1.1±0.4

associated with. This makes sense if we assume that the largest animal flushes the most insects or supplies the best perch.

Thirty one records of two bird species and one record of three species associating with the same group of mammals (mostly water buffalo) were observed.

TABLE 3

FREQUENCY OF BIRD/MAMMAL ASSOCIATION ON THE ZIMBABWE PLATEAU (AS TABLE 1)

	Cattle Egret	Forktailed Drongo
Cattle	6%	11%
goats	5%	0.5%
% of birds	70%	40%

TABLE 4

NUMBERS OF BIRDS WITH AND AWAY FROM THEIR HOSTS (AS TABLE 2)

	Cattle Egret	Forktailed Drongo
cattle	3.5	1.2
goat	7.2	1.0
total bird/mammal	4.8	1.2
away from mammals	1.4	1.1

Tables 3 and 4 present similar data from the Zimbabwe plateau. A total of 579 herds of cattle and 262 herds of goats were observed giving a lower density for each species and a much lower overall biomass of domestic animals due to the absence of water buffalo. In contrast to India the egret is a passage migrant through the area: passing quickly through around April and not associating much and again in Sept./Nov. when it does associate. The drongo is a resident but like Indian birds undergoes local movements when not breeding: in Zimbabwe this is believed to be into more open areas (Irwin 1981). Like the Cattle Egret (Blaker 1969 and this study), they associated more in the dry season. The egret appears to aggregate in larger flocks with goats than with cattle, though two large flocks of 16 and 30 were seen with goats in April, a time of year when they occur in larger groups and do not usually associate. No such flocks were seen with cattle at this time of year. The drongo appears to show no variation in numbers with either animal or away from animals.

No records of more than one species associating with the same group were obtained despite the increased rate of association. Does this imply that in India some groups are more attractive to associating birds than others? While the drongo is well known as an aggressive species, it is difficult to believe that any territorial exclusion occurs between the two species and no cases of agression were observed. In any case the drongo takes flying insects whereas the egret takes mainly grasshoppers and they are presumed not to be in competition for food.

DISCUSSION

Dean and Macdonald (1981) have divided bird/mammal associations into those which compete with their host for food and those which use the mammal to obtain their food. The myna and the crow are omnivorous taking some vegetable food and are thus potentially in competition with their hosts. The other two species are purely insectivorous (Ali and Ripley 1968-74). Another possible aspect of these associations is disease transmission but this has not actually been demonstrated (Dean and Macdonald 1981). It is possible that the birds also gain some protection or concealment from predators from these associations. It is not always clear what the mammal gains from these associations though the myna has been recorded as eating ticks in Southern Africa, where it has been introduced (Dean and Macdonald 1981) and presumably do so in India. Another suggestion is that the egret (at least) takes herbivorous insects, which compete with cattle for food (Dinsmore 1973).

All these bird species feed on insects attracted to or flushed by the mammals for instance, coprophagous beetles. Some use the mammal as a perch though egrets only do so in long grass (Siegfried 1978) and I have never observed it. Animals in woodland are less likely to have attending birds. Drongos will also use a perch on a tree or a fence near the herds for the same purpose. The other species tend to forage on the ground behind the animals though I have seen mynas preening while perched on a mammal.

I doubt if the House Crow gains significant amounts of food from these associations except perhaps by raiding grain bins. Its very ubiquity appears to lead it to perch on or around the mammals especially in the absence of other suitable perches. On the Calcutta Maiden, in the absence of the other suitable mammals, they were observed attempting to perch on goats. The goats however actively attempted to dislodge these birds by running and swinging their bodies until the crows dropped off. Unless the crows were trying to glean ectoparasites, which was not observed, I can only interpret this behaviour as a type of play (McFarland 1981).

Indian Elephants *Elephas maximus* were observed behaving similarly to dislodge mynas, which appeared to have become too numerous and too noisy, in Mudumalai Reserve in Tamil Nadu.

The crows are highly adaptable: in Calcutta zoo they were observed associating with African mammals, e.g. Eland *Tauretragus oryx.* Cattle Egret occur in larger groups with cattle but they occur with a larger percentage of groups of the bulkier water buffalo but the actual numbers of egrets associating with each species are similar. This is in contrast to the situation in Australia where water buffaloes are preferred (Siegfried 1978). This might also be a function of the more aquatic habits of the water buffalo, which appears likely to be the original host in Asia. In Africa the original host is believed to be the buffalo *Syncerus caffer,* which also prefers flooded grasslands (Siegfried 1978). The same flock sizes with and away from hosts is in contrast to the South Africa situation where flocks are larger and away from their hosts (in this case only cattle) (Blaker 1969). Cattle Egrets acquire more prey with less effort when associating with cattle (Dinsmore 1973). Smith (1971) has demonstrated this for two species of anis (*Crotophaga* spp.)

The Zimbabwe situation in the Cattle Egret is different again with same size of flocks with cattle as in India, an increased use of goats and much higher percentage of birds in associations. This is believed to be a reflection of very poor feeding conditions due to the succession of drought years which occurred in Zimbabwe during the study. The same flock size in both areas may be a reflection of territorial behaviour.

Benson (1964) reported that drongos were seen associating with five groups of cattle on a journey of 150 km in a nearby area of Zimbabwe. The former author never observed such associations by drongos in 30 years in Zambia and Malawi, which have a higher rainfall than the southern areas of Zimbabwe where these birds were observed. There is another published record from Banket (Parnell 1962). Most of these records come from low rainfall areas (less than 600 mm per year). This makes it difficult to understand why drongos in Zimbabwe did not increase in numbers when with their hosts or why they made a much lower use of goats in an area with much lower domestic mammal densities. Yet they doubled their use of cattle groups and the proportion of birds with hosts as compared with India. This suggests that the drongos were regulated by other factors like territorial behaviour. I have also observed a drongo perched on a small shrub near a chicken and apparently associating with it. This bird has been reported as associating with ostriches *Struthio cameleus* (Dean and Macdonald 1981).

I also observed Glossy Starling *Lamprotornis* sp. and a Pied Crow *Corvus albus* once each associating with cattle. It is striking that these four birds represent the same families as the birds seen in such associations as in India. Further in Britain a starling *Sturnus vulgaris* and a crow *Corvus corone* are also commonly observed in fields with domestic animals most frequently sheep. Cattle egrets and drongos do not occur in Britain. Are these birds/ families somehow preadapted to such associations more than other families? Or are they birds who have adapted well to farming habitats? The crows at least are believed to have increased with human numbers. Certainly the Cattle Egret has vastly increased its range due to its association with cattle in the wake of their range being increased to include the Americas and Australia (Siegfried 1978).

Bird/mammal assoiations have been very little studied in the tropics though the tremendous increase in the range of Cattle Egrets has generated interest in this species. It is hoped that this contribution will stimulate others to study such associations more closely.

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FISH FAUNA OF PERIYAR TIGER RESERVE[1]

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Key Words: fishes, Periyar Tiger Reserve, Kerala, India

The status and distribution of fishes in the rivers and the lake of Periyar Tiger Reserve, Kerala was studied and 35 species belonging to 7 orders and 11 families were recorded. The family Cyprinidae contained maximum number of species (13). Thirteen species of fishes collected during the study are endemic to Southern Western Ghats. Two new species, namely *Lepidopygopsis typhus* (Schizothoracinae) and *Crossocheilus periyarensis* (Cyprinidae) were recorded from Periyar while another, *Echathalakanda* (*Barbus*) *ophiocephalus* (Cyprinidae) was rediscovered from Periyar river.

INTRODUCTION

The rivers in Kerala once harboured a rich fish fauna according to earlier investigators like Pillay (1929), John (1936), Hora (1941a,b), Raj (1941a,b), Chacko (1948), Silas (1951a, b). But very little information is available on the present status of the freshwater fishes of Kerala, which are threatened by over exploitation, introduction of exotic fishes, habitat destruction and pollution. In the midlands and lowlands of Kerala many fishes have become locally extinct and are disappearing fast. A limited number of them remain in the hills; in protected areas.

Periyar is known to support several interesting and important fishes. Some preliminary studies were done on the fish fauna of Periyar (Raj 1941a,b; Chacko 1948, Silas 1951a, b). Very little is known about the current status of fish fauna in this reserve. Chacko, made an attempt to make a survey of the indigenous fish fauna in 1946, with a view to develop the fishery. He listed 35 species of fishes in the lake. Raj (1941a) has described a small scaled schizothoracine, *Lepidopygopsis typus* Raj, from the Periyar river and Hora (1941a) has described, from Mr. Jone's collection a Homalopterid loach, *Travancoria jonesi*, from Travancore.

Menon and Jacob (1991) have more recently described a small scaled Barbel, *Crossocheilus periyarensis* and rediscovered a Cyprinid fish *Barbus (Puntius) ophiocephalus* (Raj) from the Periyar river adding two more species of fishes to the fish fauna of Periyar Tiger Reserve.

The purpose of this paper is to present a status report of the fish fauna of Periyar Tiger Reserve for making comparative studies in future. It will also be helpful to identify the conservation problems and recommend management measures.

STUDY AREA

Periyar Tiger Reserve lies between 9° 16' and 9° 40' N. lat. and between 76° 55' and 77° 25' E. long. It is bordered by Kottayam and Pathanamthitta districts in the west and south, Peermade Taluk of the Idukki District in the north and Madurai district of Tamil Nadu in the east. The elevation of the Reserve ranges from 800 to 2019 m. Several peaks rise above 1600 m the prominent peak being Vellimala (2019 m).

River, Periyar which originates from Chokkampetti-Kallimalai side, about 58 Km from Thekkady with its various tributaries form the main drainage of the area. The lake, which was formed as a result of the construction of the dam has an area of 26 sq. km. Maximum depth of water at highest water level is 46 m. Two other rivers, Pamba and Azhutha also flow along the border of the reserve in the Vallakkadavu range.

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[2] Periyar Tiger Reserve, Thekkady, Kerala 685 536.

TABLE 1
FISH FAUNA OF PERIYAR TIGER RESERVE

Name of the Species	Local/Tribal Name	Locality	Relative abundance	General distribution
Order CYPRINIFORMES Family CYPRINIDAE				
Subfamily CYPRININAE				
1. *Cyprinus carpio communis* (Linn.)	Goldfish	Lake only	Common	Exotic species
2. *Puntius melanostigma* (Day)	Kudukunda	River & Lake	Very common in lake	India; Hill streams of Kerala, Nilgiris.
3. *Puntius melanampyx* (Day)	Kudukunda	River & Lake	Very common in lake	India; Hill streams of Kerala, Nilgiris.
4. *Puntius amphibius* (C. & V.)	Kooral	Azhutha, Pamba	Common	India; Peninsular India, Sri Lanka.
5. *Puntius mahecola* (Val.)	Karuva/Paral	” ”	”	”
6. *Puntius filamentosus* (Valenciennes)	_	” ”	”	
7. *Echathalakanda ophiocephalus* (Raj)	Ectilakanta	River above Mlappara Ummikkuppanthodu	Rare	India; Kerala Hill stream. Rediscovered from Mlappara.
8. *Tor khudree* (Sykes)	Kuyil	River & Lake	Common	India; Deccan and P. India; Sri Lanka.
9. *Garra mullya* (Sykes)	Kallemutti	River & Reservoir	Common	India; Hill streams of P. India.
10. *Garra gotyla stenorhynchus* (Jerdon)	”	” ”	”	India; Western Ghats, Cauvery & Krishna drainages.
11. *Hypsilobarbus kurali* (Menon & Rema Devi)	Kooral	Stream & Lake	”	India; Dakshina Kannada to Travancore Hills.
12. *H. periyarensis* (Raj)	Kariyan	Fast flowing rivers	”	India; Kerala, Periyar.
13. *Crossocheilus periyarensis* (Menon & Jacob)	Karimbachy	River above Thannikudy	Rare	”
Subfamily SCHIZOTHORACINAE				
14. *Lepidopygopsis typus* Raj	Brahmana Konda	Periyar above river	”	India; Kerala, Periyar river system.
Subfamily RASBORINAE				
15. *Parluciosoma daniconius* (Ham.)	Kannanjon	Lake, Azhutha stream	Very common	India; Sri Lanka, Pakistan, Nepal, Bangladesh, Myanmar (Burma), Thailand.
16. *Barilius bendelisis* (Ham.)	Pavukan	Thannikudy, Lake, River	Common	India; Pakistan, Nepal, Bangladesh.
17. *B.bakeri* Day	”	”	”	India; Kerala, W. Ghats.
18. *B. gatensis* (C. & V.)	”	”	”	Peninsular India, W. Ghats.
19. *Danio aequipinnatus* (McClell.)	--	Azhutha, Pamba	Very common	India; Nepal, Bangladesh, Myanmar, Thailand.
Family HOMALOPTERIDAE				
20. *Travancoria jonesi* Hora	Kallotty	Rivers above Thannikudy	Rare	India; W.Ghats, High Ranges of Kerala.
Family COBITIDAE				
21. *Lepidocephalus thermalis* (C. & V.)	Ayira	Lake/River	Common	P. India; Sri Lanka.
22. *Noemacheilus botia*	Ayira	Small streams	Rare	Hill stream of Travancore.
23. *N. triangularis*	”	”	”	India; W. Ghats.

Table 1 (Contd.)

Name of the Species	Local/Tribal Name	Locality	Relative abundance	General distribution
24. *N. evezardi*	Ayira	Small streams	Rare	India; W. Ghats and Madhya Pradesh.
Order SILURIFORMES				
Family Heteropneustidae				
25.*Heteropneustes fossilis*	Kary (Bloch)	Lake	Very Common	India; Pakistan, Sri Lanka, Nepal.
Family Siluridae				
26. *Ompok bimaculatus* (Bloch)	Chottavala	Lake		India; Pakistan, Nepal, Bangladesh, Myanmar, Thailand, Java, Sumatra, Borneo.
Family Sisoridae				
27.*Glyptothorax madraspatanum*	Parayotti (Day)	Thannikudy	Uncommon	India; W. Ghats.
Order ANGUILLIFORMES				
Family Anguillidae				
28. *Anguilla bengalensis*	Mlanjil	Azhutha	Uncommon	India; Pakistan, Sri Lanka, Myanmar.
Order ATHERINIFORMES				
Family Cyprinodontidae				
29. *Aplocheilus lineatus lineatus*	Poonjan	River & Lake	Very Common	Peninsular India.
Order PERCIFORMES				
Family Cichlidae				
30. *Oreochromis mossambica* (Peters)	Thilapi	Lake	Very common	Introduced.
Family Channidae				
31. *Channa striata* (Bloch)	Varal	Lake	Rare	India; Sri Lanka, Pakistan, Bangladesh, Nepal, Myanmar, Malaya, Malaya Archipelago, Thailand up to Philippines.
32. *C. orientalis* (Bloch & Schn.)	Vatton	Lake & Rivers	"	India; Iran, Afganistan, Nepal, Pakistan, Sri Lanka, Bangladesh, Myanmar, Thailand, Yunan, Malaya, Malay Archipelago, Hainan, and Taiwan.
33. *C. marulius*	Cherumeen	Azhutha, Pamba	"	India; Pakistan, Sri Lanka, Bangladesh, Nepal, Myanmar, Thailand, Sumatra, Borneo, China.
Order MASTACEMBELIFORMES				
Family Mastacembelidae				
34. *Mastacembelus armatus* (Lacep.)	Aaron	River, Lake	Common	Pakistan, Sri Lanka, Nepal, Thailand, India, Myanmar, Malaya to South China.
35. *Macrognathus aral* (Bloch & Schn.)	"	Vazhukkappara stream	Rare	India; Pakistan, Sri Lanka, Vietnam, Bangladesh, Nepal, Myanmar, Thailand, Laos, Malaya and East Indies.

Materials and Methods

Fish samples were collected from January, 1992 to December, 1994 from different localities in the rivers and lakes while conducting wildlife studies. The collections were made from the Periyar river, Mullayar river, and their tributaries and different areas of the reservoir; boat landing, near dam, Mullakkudy, Manakkavala, Swamikkayam and

Padikkayam. Fishes were also collected from rivers Pamba and Azhutha.

Fishes were collected by gill-nets, cast-nets, hooks and bait. Worms, grasshoppers, small fishes, fruits of some trees, boiled tapioca and even rice paste were used as baits. For collecting small fishes, a special method called "Vatty" was used. Some were collected from local fisherman. Fishes were preserved in 5% formalin and identified in the laboratory.

Results and Discussions

Thirtyfive species of fishes, representing 21 genera and 11 families were collected and identified (Table 1). Morphological particulars of these species are available in Day (1876-88), Hora (1941a,b), Silas (1951a,b), Munro (1955), Talwar and Jhingran (1991). Out of the 33 species mentioned in the list of Chacko (1948), species like *Mystus cavasius* (Ham.), *M. vittatus* (Bloch), *Notopterus notopterus* (Pallas), etc., were neither found in the reservoir nor in the tributaries of Periyar and Pamba during this survey.

The species *Parluciosoma daniconius* (Ham.), *Puntius melanamphyx* (Day), *Hypsilobarbus kurali* (Menon & Rema Devi), *Garra mullya* (Sykes) were collected from almost all localities of the reservoir. Among these 35 species, about 13 species are usually found in upper streams and are adapted to lotic torrential waters. They are *Travancoria jonesi* (Hora), *Garra mullya* (Sykes), *Garra gotyla stenorhynchus* (Jerdon), *Tor khudree* (Sykes), *Hypsilobarbus periyarensis* (Raj), *Crossocheilus periyarensis* (Menon & Jacob), *Barbus ophiocephalus* (Raj), *Lepidopygopsis typus* (Raj), *Noemacheilus evezardi* (Day), *Glyptothorax madraspatanum* (Day), *Barilius bakeri* (Day), *B.bendelisis* (Ham.) and *B. gatensis* (Cuvier & Val.). Some of them are adapted to cling to the substratum by some attachment devices, e.g. *Garra, Travancoria* and *Glyptothorax.*

Fishes like *Heteropneustes fossilis* (Bloch), *Ompaok bimaculatus* (Bloch), *Channa striatus* (Bloch), *C.orientalis* (Bloch & Schn.), *C.marulius* (Ham.), *Cyprinus carpio communis* (Linn.), *Oreochromis mossambica* (Peters), etc., are restricted to lentic waters of the reservoir.

Among the hillstream fishes *Crossocheilus periyarensis* (Menon & Jacob), a rare species was a new discovery from Periyar. Another fish which was believed to be extinct, *Barbus ophiocephalus* (Raj) was rediscovered. *Lepidopygopsis typus* (Raj), *Hypsilobarbus kurali* (Menon & Rema Devi), *Tor khudree* (Sykes), *Travancoria jonesi* (Hora) are some of the endemic species of the Southern Western Ghats. Preliminary studies on the food habits of Tor (through stomach content examination) have indicated that this species took a variety of fruits.

Conservation and Management

"Mannan" and "Paliyans" (local tribals) above forty years of age speak of abundant fish in all the rivers, especially in Periyar and in the reservoir in the past. According to them, this abundance was due to undisturbed conditions of Periyar, Mullayar and their tributaries. But now all these areas are disturbed by indiscriminate fishing, deforestation, hunting, etc. In addition, new exotic fishes which were introduced to the reservoir, namely *Oreochromis mossambica* (Peters) and *Cyprinus carpio communis* compete with native species of fishes for food and habitat.

Recommendations

1. Fishing activities in Periyar should be controlled.
2. Fishing during monsoon, which is the breeding season of most of the fishes should be banned.
3. Research should be conducted for assessing population density and habitat requirements of fishes in the rivers and lake.
4. Remove the introduced fishes from the reservoir and restock with fingerlings of species like *Tor khudree* (Sykes), which has sport value.
5. Sport fisheries could be developed to cater to

the needs of tourists in the tourist zone which could generate revenue for the Government.

6. *Puntius melanampyx* could be used as an aquarium fish.
7. Plant trees on the lake edges for providing food for species like Tor.

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PRELIMINARY OBSERVATIONS ON THE IMPORTANCE OF A LARGE COMMUNAL ROOST OF WINTERING HARRIERS IN GUJARAT (NW. INDIA) AND COMPARISON WITH A ROOST IN SENEGAL (W. AFRICA)[1]

Roger Clarke[2]

Key words: Gujarat, locust, Montagu's Harrier, Pallid Harrier, pellets, roosting

The largest communal roost of wintering harriers in the world reported in recent times occurred in the grassland at Velavadar National Park, Gujarat, north-west India. It consisted of up to 2000 birds, mainly Montagu's Harriers *Circus pygargus* (about 75%) and Pallid Harriers *Circus macrourus* (about 20%) and has been known since the mid 1980s. Pre-roosting, roosting and post-roosting behaviours are described. About 30% of the harriers present were adult males, but only one dark morph Montagu's Harrier was recorded. Foraging behaviours are described; the Montagu's Harriers fed mainly on locusts in shrublands and cotton fields and male Pallid Harriers were observed hunting small birds in grassland. Of 134 pellets collected at the roost, 60% contained locust remains, principally of the Tree Locust *Anacridium rubrispinum*. It was calculated that the harriers attending the roost probably consumed more than 1.5 million locusts each winter. The rest of the prey remains in the pellets were mainly of small birds, principally larks, although the remains of a few mammals and reptiles also occurred. The roost is compared to one found in Senegal, West Africa.

Introduction

More than 1500 Harriers were counted roosting at Velavadar Blackbuck Sanctuary and National Park, Gujarat, north-west India in November 1991 (W.S. Clark *in litt.*). This appears to be the largest roost of harriers recorded in the literature since nineteenth century observations of thousands of Montagu's Harriers roosting after the breeding season and before migration at a marsh in the west of France (Barbier Montault 1838). The great majority of harriers at Velavadar were Montagu's Harriers *Circus pygargus* (about 75%) and Pallid Harriers *C. macrourus* (about 20%), but very few Marsh Harriers *C. aeruginosus* and one or two ringtail Hen Harriers *C. cyaneus* were also present. This paper details observations during two visits to Velavadar, on 1-6 February 1992 and 25-31 January 1993. On my first visit I collected 134 pellets from two settling areas which were attracting about 500 and 300 birds respectively at the time. The results of my analysis of the pellets and observations of foraging and roosting behaviour are given below and compared with observations on harriers and the results of analysis of 113 pellets collected at a roost of about 1000 Montagu's Harriers in late December 1988 and early January 1989 near M'bour, Senegal, West Africa (Cormier and Baillon 1991).

Roost Catchment Areas

The Indian roost site (22° North) is in a remnant of grass plain occupying the northern half of 17.38 sq. km of land preserved as a National Park in 1976 to conserve the Blackbuck *Antilope cervicapra.* The Park is situated in a semi-arid area of alluvial plain known as the 'Bhal' (reputed to mean 'forehead', i.e. a bare, open landscape), on the western shore of the Gulf of Khambhat (Arabian Sea). Some land between the Park and the Gulf of Khambhat (20 km away) is a saline wasteland irregularly inundated by the sea in the monsoon, but much of the surrounding plain consists of shrublands of Mesquite *Prosopis chilensis* and large arable fields, in winter, mainly growing a special strain of cotton not requiring irrigation. A high proportion of the fields were ploughed at the time of my visits and cotton was being harvested. In the day, many Montagu's Harriers were observed hunting over the cotton fields.

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The African roost site (14° North) is situated close to the Atlantic coast in fairly flat, open savannah with abundant ground vegetation and a few trees. The harriers hunted around brackish lagoons, in savannah and dunes, not over crops.

Roost Sites

The Indian Harriers roosted in a *Dichanthium*-dominated grass community about 40 cm tall in large, totally open fields which had been used as hay plots and were now maintained just by shrub clearance, although bordered by hedges of shrubs, especially *Prosopis chilensis.*

The African roost was in ground vegetation in an area of savannah with some trees, principally *Ziziphus mauritiana,* and with scattered humps of old termite mounds 1-1.5 m high. Domestic grazing herds, mainly of goats and cattle, crossed the site by day, but the ground vegetation was still quite dense.

Pellet Analysis Methods

For the purposes of this paper, the term 'locust' includes large grasshoppers. Pellets from India containing only locust or a mix of locust and reptile remains were dissected dry. Pellets at least partly made up of bird or mammal remains were dissected wet and the remains were washed and allowed to dry. Pellets of pure locust remains were very fragile and liable to break in two on the ground or when collected. The collection comprised 46 part pellets, which were counted as 23 whole pellets, and 111 whole pellets to give the equivalent of 134 pellets. The locusts were identified from the manual issued by the Centre for Overseas Pest Research (1992) and specimens in the collection of the Bombay Natural History Society. The number of locusts in each pellet was taken as the highest number represented either by mandibles or by ovipositor valves. Care had to be taken to identify dorsal and ventral pairs of ovipositor valves to arrive at the correct number of female locusts that they represented. Counts of locusts from mandibles were based on the highest number of right or left mandibles in the pellet. Bird remains were identified by matching against reference collections. Larks were counted by means of bill parts or hind claws. Pigeons and doves were recognised from their white down and feather fragments. Sparrows were recognised and counted by the palatal thickenings from their bills. Bird remains which could not be identified were counted as one bird per pellet, but were few in number. Reptiles could not be enumerated or identified since remains were almost entirely loose scales. One pellet contained a lizard jaw. Mammals were identified from their fur and teeth. Indian Bush Rat *Golunda ellioti* and Gerbil *Tatera indica* teeth were identified from the early, but accurate illustrations in Blanford (1888). Mice and rats were identified from hair, jaws or incisors. Lagomorph fur was confirmed by microscopic examination of the medulla (Koppikar and Sabnis 1976).

Observations

Roosting, pre-roosting and post-roosting behaviour: The number of harriers using the Velavadar roost fluctuated during each winter. In both 1991 and 1992, large counts (1500-2000) were made in November/December. Later in each winter, numbers dropped in January/February (800 birds in early February 1992 and 600 declining to 300 in late January 1993). The full seasonal pattern is yet to be established, but it seems likely that the roost is reduced in size from midwinter because birds pass south before coming back on return migration. Further large roosts are known or suspected south to Andhra Pradesh (southeast India) and research is required to ascertain whether they peak later (A. Mulchandani, pers. comm.). Migration of harriers from the direction of Gujarat through the Western Ghats has been observed in the past (Khacher 1977).

The Indian harriers were using at least two pre-roosting areas of bare, flat, dried mud, separated from the night-roost grassland by *Prosopis chilensis* thickets. Up to 126 harriers (26 January 1993) were counted on the largest of these. Only a proportion of the harriers seemed to be using them, since a constant stream of harriers passed by, heading for the grassland night-roost. The pre-roosting harriers stood facing into the wind, well spread out in loose groups. The mud was generally very flat, but many individual harriers were noted perching on the slightest lumps projecting from the surface. Numbers built up until about sunset. After sunset, these pre-roosts would gradually disperse, individuals and small groups flying off to the night-roost.

Especially with a good breeze, aerial activity at the night-roost was on two levels. The number of birds 'milling' above the night-roost quickly built up into a mass of up to several hundred birds towering one hundred metres or more above the settling area. At the same time, a significant number was positioned much higher in the sky, using the warm air until well after sunset and then individuals folded in their wings to stoop down to lower levels, criss-crossing each other's flight paths in the sky, to join the roost. Occasionally a separate tight 'carousel' of circling birds would form. The cause of these could not be ascertained at the time, but subsequent observations suggest that they are a mutual warning mechanism alerting birds to predators in the grass. On some evenings the harriers formed up to three groups of birds milling in the air, which roosted in separate parts of the grassland. Settling by hundreds of birds took place quite rapidly at about twenty minutes after sunset and with some hesitation over places, switching of places or displacement of one harrier by another.

The Velavadar harriers dispersed from the roost at an early dawn. By sunrise almost all had gone, principally in flight-lines south to the main post-roost and west to the main cotton fields and shrublands. Male Pallid Harriers (grey males only identified with certainty in the poor early morning light) left in the same direction as the other harriers, but on average a few minutes later than male Montagu's Harriers, and generally at lower altitude.

The largest pre-roosting area was watched on the morning of 31 January 1993 and at its peak, 81 harriers post-roosted on the ground there. They stood around in exactly the same manner as at pre-roost, preening a little and eventually flying off before sunrise. A dispute over food between 3 or 4 individuals was noted, involving some chasing low over the ground.

The African harriers (Cormier and Baillon 1991) are described as arriving at the roost site in the one and a half to two hours up to dusk, the first ones continuing to hunt over the site and settling on mounds or trees to deal with the prey caught, then taking flight to settle a little later. Communal aerial activity is described as the formation of as many as two or three simultaneous carousels of hundreds of birds each night at about 15-20 minutes before dusk as they took flight in alarm, which subsided before the harriers generally took to the air prior to finally settling. No observations of morning dispersal are given.

Proportions of grey males and dark morphs: Cormier and Baillon (1991) recorded only 11% grey males in Senegal, but made the point that this was probably the result of differing preferences of males and females for certain wintering areas. At Velavadar, I recorded an average of 30.5% adult grey males, Montagu's and Pallids combined, from counts (n = 11 counts, 397 birds in total) at the pre-roosts. Successive counts were made at each pre-roost to attempt to average out the effect of any difference in arrival and departure times of the sexes. For example, on 26 January 1993 at 1807 hours there were no grey males out of 16 birds, but 17 out of 35 birds at 1841 hours. On the January 1993 visit, I noted that a few of the juvenile Montagu's harriers present showed signs of moult into adult male plumage with grey heads, throats and upper breasts. To my knowledge, just one dark morph harrier has been seen at Velavadar — a totally dark brown female Montagu's Harrier observed once in flight towards the roost in January 1993 (R. Naoroji, pers. comm.). This is in contrast to the situation in Senegal where 5% of the Montagu's Harriers present were dark morphs (Cormier and Baillon 1991).

Foraging behaviour: The great majority of harriers observed foraging over the cotton fields close to Velavadar were Montagu's Harriers. Each one hunted intensively and alone over a field or two, flying 3-4 m above the crop looking down into it for locusts. The locusts were not swarming and I had to search through the crop intently to see any. Strike rate success was casually assessed as on average once every 10-15 minutes. Strikes were usually a feet-first descent with wings upraised, but shallow stooping was observed once. The rows of cotton plants were about 1m apart and the harrier would momentarily disappear amongst them. After a successful strike, they flew with the locust held firmly at each end, clearly visible in lowered talons and sometimes in tandem much in the manner of an Osprey *Pandion haliaetus* carrying a fish. To eat the locust, they flew to an open piece of ground such as a ploughed field or a trackway. Occasionally they fed on the locust in flight, bill and talons being brought together to meet, in the manner of a Hobby *Falco subbuteo* feeding on insects. There was a lull in hunting activity during the heat of midday, when the harriers tended to circle up in the sky in ones and twos.

The few harriers I saw on the Velavadar grassland during the day were adult male and juvenile Pallid Harriers. They mostly hunted earlier and later in the day, but also at midday if it was overcast. Whilst it was warm, they flew slowly into the wind with 3-4 shallow flaps between each glide, then turning to drift quickly downwind, and repeating. In early morning and evening I saw fast low-level flight, with agile swerves at small birds, reminiscent of the fast, low bird-hunting flight mode of the Hen Harrier (Wassenich 1968). One stoop at potential bird prey on the ground from a few metres height was observed (an unsuccessful strike). I saw one of the adult male Pallid Harriers in fast, determined level chases of small birds that he had flushed or missed on a strike, clearly with some expectation of success.

PELLET ANALYSIS RESULTS

The principal prey in the pellets from both continents (Tables 1 and 2) were locusts, in Senegal predominantly the Desert Locust *Schistocerca gregaria*, and in Gujarat the Tree Locust *Anacridium rubrispinum*. Locusts featured in 97% of African pellets and 60% of Indian pellets respectively. In the African pellets, Cormier and Baillon (1991) found that ovipositor valves of female locusts greatly outnumbered mandibles. They commented that the male sub-genital plates were difficult to detect and so females greatly predominated in the analysis, although they give no hard figures. Only females could be identified in the Indian pellets, since no male sub-genital plates were evident. However, pairs of mandibles usually substantially outnumbered the count of females in pellets, based on ovipositor valves, contrary to the African results.

Table 1

PELLETS CATEGORISED BY PREY CLASSES

	Gujarat		Senegal*	
	n pellets	%	n pellets	%
Locust only	54	40	84	74
Locust & bird	6	4	3	3
Locust & mammal	8	6	21	18
Locust & reptile	9	7	2	2
Locust, bird & reptile	3	2		
Locust, mammal & reptile	1	1		
`Absence of locusts'			3	3
Bird only	32	24		
Bird & mammal	3	2		
Bird & reptile	6	4		
Bird, mammal & reptile	2	2		
Mammal only	8	6		
Mammal & reptile	2	2		
Total	134		113	

* Cormier & Baillon (1991).

Cormier and Baillon (1991) concluded that the harriers in Africa often did not eat the heads of locusts, preferring the content of the abdomen. The predominance of mandibles in the Indian pellets suggests that this was not the case in India. However, remains collected from one 'plucking' place consisted mainly of wings representing about 6 locusts, 5 pronotums, 7 whole and 3 part hind-legs femurs (6 with the rest of the leg attached), and 3 heads. All remains were that of Tree Locusts apart from one Black-spotted Grasshopper *Cyrtacanthacris ranacea* hind-wing.

Of the bird prey, larks could not be identified to species. Pigeons and doves identified in the pellets included Blue Rock Pigeon *Columba livia*, Collared Dove *Streptopelia decaocto*, Little Brown Dove *S. senegalensis* and Green Pigeon *Treron phoenicoptera*.

TABLE 2
PREY IDENTIFIED IN INDIAN AND AFRICAN PELLETS

	Gujarat n	Senegal* n
Desert Locust *Schistocerca gregaria*		1355
Tree Locust *Anacridium rubrispinum*	614**	
Other locusts or grasshoppers		
India — Black-spotted Grasshopper		
Cyrtacanthacris ranacea	68**	
Africa — (*Acrida* sp.)		167
Other insects (mostly Coleoptera)		55
Birds		
Larks	47	
Pigeons and doves	7	
Sparrows *Passer* spp.	4	
Unidentified	18	5
Mammals		
Indian Bush Rat *Golunda elliotti*	12	
Rat *Rattus* spp.	2	
Mouse *Mus* spp.	1	
Indian Gerbil *Tatera indica****	3	
Indian Hare *Lepus nigricollis*	1	
Unidentified	6	23
Reptiles		
Agamas		2
Unidentified — number of pellets containing remains (unquantifiable as to number of individuals)	23	

* Cormier & Baillon 1991.
** Total count of 682 locusts from mandibles, etc. (see Methods) apportioned according to the ratio of the pronotums of the two species found in the pellets (209:23).
*** Possibly Indian Desert Gerbil *Meriones hurrianae*.

DISCUSSION

The Senegal roost materialised in response to the largest explosion in the population of the Desert Locust in the area for 20 years, with large swarms south of Dakar. In contrast, the Velavadar roost has been known since 1984 (S.Rooke, pers. comm.) and has recurred each winter. The economic value of such roosts can be measured firstly in terms of the number of locusts eaten and secondly in their wildlife tourism potential. A tentative calculation of the number of locusts taken from the surrounding fields by the Velavadar roost in each of the winters might be based on an average of 750 harriers (mean from pattern of nil at beginning, 1500 peak, nil at end) for 182 days (October to March) consuming 10 locusts on average (calculated from 682 locusts /134 pellets in my sample = 5 x say 2 pellets per day) = 1.365 million. This can be regarded as an underestimate, since the pellet analysis probably significantly undercounts the number of locusts eaten because some heads are discarded and locust pellets disintegrate faster probably reducing the number collected. Calculated another way, 750 harriers on average x 75% (Montagu's Harriers) x 182 days x 2, 2-hour hunting sessions producing 8 locusts each (one every 15 minutes) = 1.64 million. Without further research these figures are crude estimates, but the true figure is probably in excess of 1.5 million. This is one measure of the worth of a protected grassland.

Five locusts were caught in the cotton fields close to Velavadar by M. Pai, three of which were Black-spotted Grasshoppers and two Tree Locusts. Despite the tiny sample, this was a surprising result in view of the scarcity of the Black-spotted Grasshopper in the harrier pellets and prey remains examined (about 10% of locusts). It begs the questions: 1. Were more of the boldly-patterned creamy-yellow and black Black-spotted Grasshoppers caught because they are more obvious to the human eye than the uniformly greyish-pink Tree Locusts? or 2. Do the harriers select Tree Locusts — either for palatability or for ease of capture? Further research is required to answer these questions.

The broader food niche of the Velavadar roost is of course to be expected because of the range of harrier species there. Considering the Senegal results, it might be assumed that the pellets of locust remains at the Indian roost were mainly those of the Montagu's Harriers present, and this could be largely correct. Observation of the birds leaving the roost in the morning emphasised the difference in the flight actions of at least the males of the two principal species. The Montagu's Harriers were able to leave at an early dawn, intermittently flapping gently and gliding out towards the croplands on their relatively larger wings, whereas the Pallid Harriers left later and at lower altitude. Schipper (1977) found that

Montagu's Harrier ranged further from the nest than other species of harrier sympatric with it in western Europe and obtained enough return for hunting effort from smaller prey. This appears to be because of its light wing loading (Nieboer 1973). Locust prey therefore suits Montagu's Harrier well despite its small size and its quantity provides the biomass necessary to attract maximum number of birds to one area. This was not only the case at Velavadar and in Senegal, but 'grasshoppers' were also the principal prey when Montagu's Harriers roosted in thousands in France in the nineteenth century (Barbier Montault 1838).

I suspect that the Pallid Harriers took the largest share of bird prey at Velavadar. The Pallid Harrier is larger than Montagu's Harrier. It exhibits a greater degree of reversed sexual size dimorphism, has proportionately larger feet and claws, and shorter but proportionately more tapered wings (Nieboer 1973). These adaptations point to feeding on birds. Size dimorphism is generally greater in bird-eating raptors (Newton 1979) and larger feet assist in grasping manoeuvrable prey. The slimmer wing structure of the Pallid Harrier favours swifter flight for chasing birds. There is relatively little information on the diet of the Pallid Harrier on its breeding grounds in the steppes of western and central Asia. Early information indicated that the majority of breeding season food was small mammals (80% according to pellets analysed — Osmolowskaja in Glutz von Blotzheim *et al.* 1971), but birds have recently been found to constitute an important part of the breeding season diet, especially when rodents are scarce (Davygora and Belik 1994).

Apart from larks, the Velavadar grassland itself appeared to hold little prey for the harriers. This is in contrast to the situation in Andhra Pradesh (southeast India), where Rahmani and Manakadan (1986) found grasshoppers so abundant that they flushed a few at every step, and 'during the day, fifty to sixty harriers... tirelessly quartering the grassland' at a roost of 800-1000 harriers (mainly Montagu's) in the 1985-86 winter. Similar findings were made by Satheesan and Rao (1990) who identified both large and medium-sized grasshoppers consumed.

The Marsh Harrier is the largest species of harrier, with the shortest wings and tail relative to body size (Nieboer 1973), and so some of the larger prey items in the Indian pellets, such as hare, might be attributed to them.

The occurrence of Hen Harriers at the Indian roost shows, for a few individual birds, that the species' distribution extends south of that quoted in Ali and Ripley (1978).

Further work to be done on harrier roosts in India should include an assessment of pesticide ingestion by harriers, especially in view of the importance of such a large number of harriers to the Asian breeding population. It is possible that they acquire organochlorines in parts of India which affect their success on breeding grounds. Montagu's Harrier is under threat in many areas of the western part of its breeding range. This makes the gaining of an understanding the eastern component of the world population all the more urgent. The status of the more easterly-biased world Pallid Harrier population is not well known, although recent information suggests that the east European breeding population has largely vanished and there may have been some shifting of the range of the Asian breeding population due to major losses of habitat to grazing and agricultural use (Davygora and Belik 1994).

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STUDIES ON AMPHIPODS OF VISAKHAPATNAM COAST[1]

P. Somanadha Rao, K. Hanumantha Rao and K. Shyamasundari [2]

(*With three plates*)

Key words: nine genera, nine species, planktonic amphipods, Visakhapatnam

During a survey of amphipod fauna of Waltair coast, some gammaridean amphipods were encountered. Nine species belonging to five families and nine genera are described. The order Amphipoda comprises four sub-orders the Gammariidea, Hyperiidea, Caprelliidea and Ingolfelliidea. According to Barnard (1969) the constant presence of atleast 6 pairs of thoracic appendage, five pairs of gills and four pairs of brood lamellae in females are distinctive characters of Gammariidea and Hyperiidea.

Some of the recent contributions on the taxonomy of amphipods are those of Bellan-Santini and Dauvin (1981), Dickinson (1982), Goeke and Heard, Jr. (1983, 1984), Andres (1985), Goeke (1985, 1987), Thomas and Barnard (1986) and Locke and Corey (1989).

Samples were collected twice a week by towing a plankton net for a definite time. Each sample was used for numerical estimation and identification in living condition. All collections were made in Lawson's Bay, 1 km away from the coast. Samples collected during June, 1984 and May, 1987 form the material for the present study.

Family Ampeliscidae
Genus *Ampelisca* Krøyer

Ampelisca zamboangae Stebbing
(Plate 1, Figs. 1-10)

Body transparent. The distinguishing character is the fifth peraepod (Fig. 1). The expanded second joint reaches beyond the third joint. The flagellum and antenna of female have three segments. Coxal plate of first gnathopod (Fig. 4) broader towards the distal end fringed with plumose setae, second joint of second gnathopod elongate, devoid of setae, fifth and sixth joints subequal and setose, sixth narrow distally. Peraeopod description is similar to that given by Sivaprakasam (1966). The outer ramus of the third uropod is longer than the inner ramus. There are four spines on the outer surface and three setae on the inner surface of the outer ramus. There is a deep notch in the telson, each lobe bearing a spine and four setae at its distal end.

Length: 4.5 mm.

Occurrence: Lawson's Bay — 3 males; 3 females.

Distribution: Philippines, Sri Lanka, East Indies, Arabian Sea, Red Sea and Bay of Bengal.

Family Haustoridae
Genus *Urothoe* Dana

Urothoe ruber Giles
(Plate 1, Figs. 11-14)

Remarks: Fairly common in plankton.

Head slightly reduced. A common form in the plankton. First antenna 5-jointed with a 2-jointed accessory flagellum. Second antenna longer than the body.

First gnathopod subchelate. Fifth joint longer than sixth. There are long setae on the second joint. In the second gnathopod, fifth joint is narrower than that of the gnathopod one. Sixth joint apically produced to form chela with dactylus. Long setae on 2nd and 3rd joints. The first two peraeopods are alike (Fig. 12). Fourth joint long, sixth joint club-shaped and bears stout spines. Seventh joint cannot be distinguished from the spines of the sixth joint.

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The joints of the third peraeopod and plumose setae. Fourth and fifth peraeopods have a flat joint.

Uropod 1 and 2 are alike. In the third uropod (Fig. 14) the rami are flattened and bear long plumose setae along the margins. The cleft telson has five distal spines.

Length: Male 3.3 mm; Female 4.4 mm.

Distribution: Bay of Bengal.

Genus *Platyischnopus* Stebbing
Platyischnopus herdmanii Walker

(Plate 1, Figs. 15-17)

A number of males and a few females were seen in plankton. Rostrum oblong. Head fairly long, longer than the first four segments put together. First antenna with a two jointed accessory flagellum. Antenna extends beyond the body. Second antenna shorter than the first.

First gnathopod has a distally expanded second joint (Fig. 15). Third and fourth joints subequal in length. Sixth joint forms a chela with the seventh. Second gnathopod similar to the first. The structure of the peraeopods agree with the description given by Walker (1904). First two peraeopods similar with a distally expanded fourth joint. Fifth peraeopod long and narrow. Telson cleft, each lobe with a strong stouter tooth and 2 distal setae.

In the third uropod the inner ramus is small with a pointed apex. The outer ramus is 2-jointed with a spine-like second joint.

Occurrence: Lawson's Bay — throughout the year.

Distribution: Sri Lanka, South Africa, Arabian Sea and Bay of Bengal.

Family Oedicerotidae
Genus *Perioculodes* O. Sars
Perioculodes megapleon (Giles)

(Plate 2, Figs. 18-26)

Body uniformly broad, with a short rostrum. Pleon segments large. First antenna short, stout, with the peduncle bearing setae. Flagellum 9-jointed and fringed with fine hairs. The joints of the peduncle of second antenna decrease in width. In male, the flagellum is longer than the body.

The two gnathopods are similar, subchelate. First gnathopod with second joint very long and slender. Palm slightly oblique, with fine teeth. Second gnathopod similar to first, but slightly longer. Palm more oblique than the first. Seventh joint forms a chela with the fifth.

First and second peraeopods similar. Fourth, fifth and sixth segments properly setose. Sixth segment with 3 spines, seventh indistinguishable from setae. In the third peraeopod, second segment is broader. Third is small, rest are slender; long hairy setae on every segment. Dactylus spiniform, with a fringe of hairy setae. Fourth peraeopod is slightly longer than the third. Fifth leg (Fig. 23) is longer than the preceding legs.

Uropods (Figs. 24-26) are similar in structure. Peduncle longer than the rami, with terminal spines. Rami fringed with setae on both margins. The length decreases successively from first to third uropod. Telson bilobed, with four setae.

Family Gammaridae
Genus *Hornellia* Walker
Hornellia incerta Walker

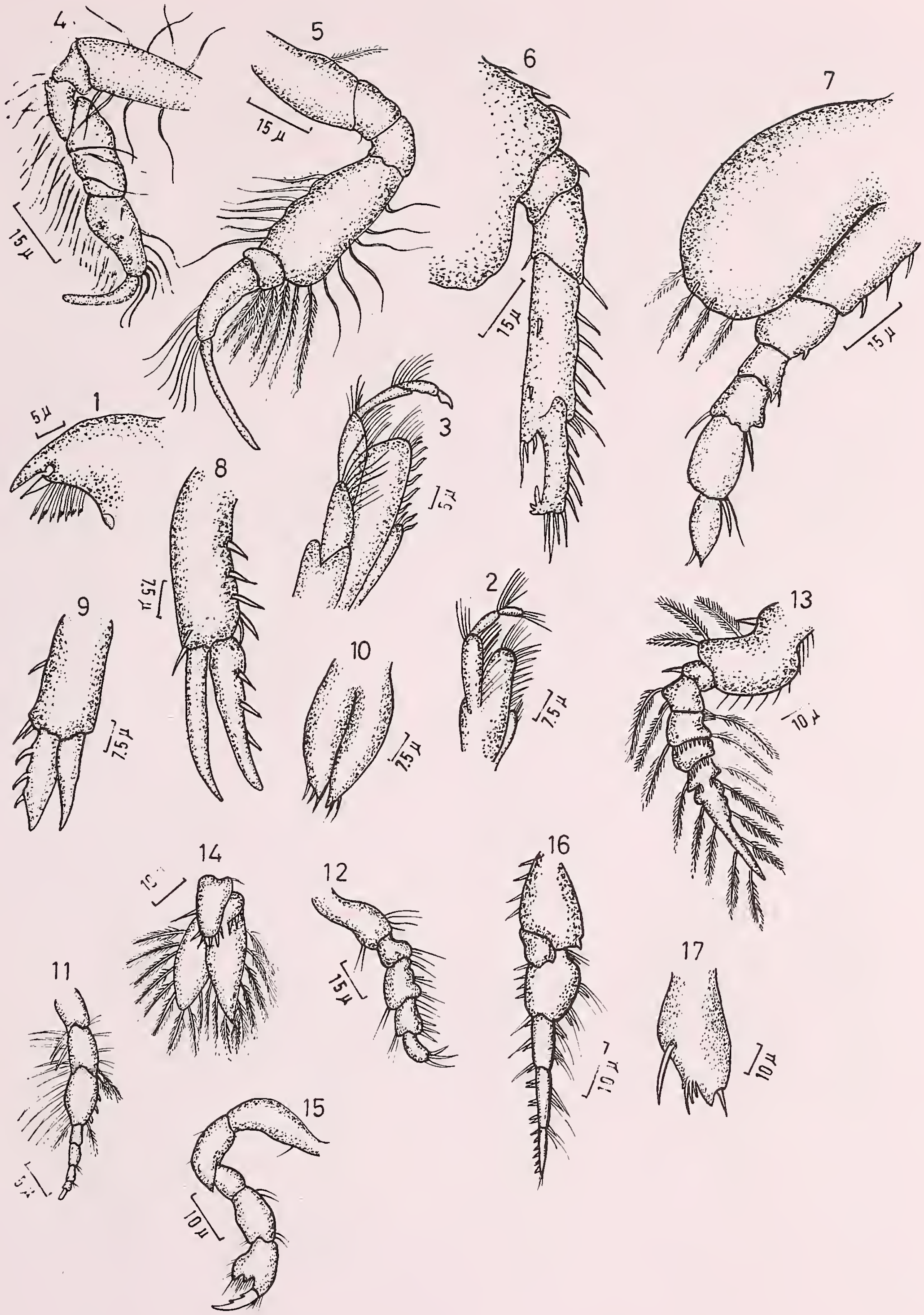
(Plate 2, Figs. 27-29)

Body has serrated pleon segments. Peduncle of first antenna fringed with short hairs. A long 20-jointed flagellum and 2-jointed accessory flagellum. Flagellum longer in males than in females. In the first maxilla, the second joint of the palp has small spines alternating with larger spines unlike that observed by Walker (1905).

Both gnathopods similar with triangular fifth joint. Palm border possesses spines (Fig. 27). Except the first two, all other peraeopods are long, with all segments spiny. Firt uropod (Fig. 28) is the longest and reaches slightly beyond the third uropod. Outer ramus of the first and second uropods shorter than the inner. Rami of third uropod (Fig. 29) unequal, inner border with a few plumose setae.

Length: 4.0 mm.

Occurrence: Lawson's Bay.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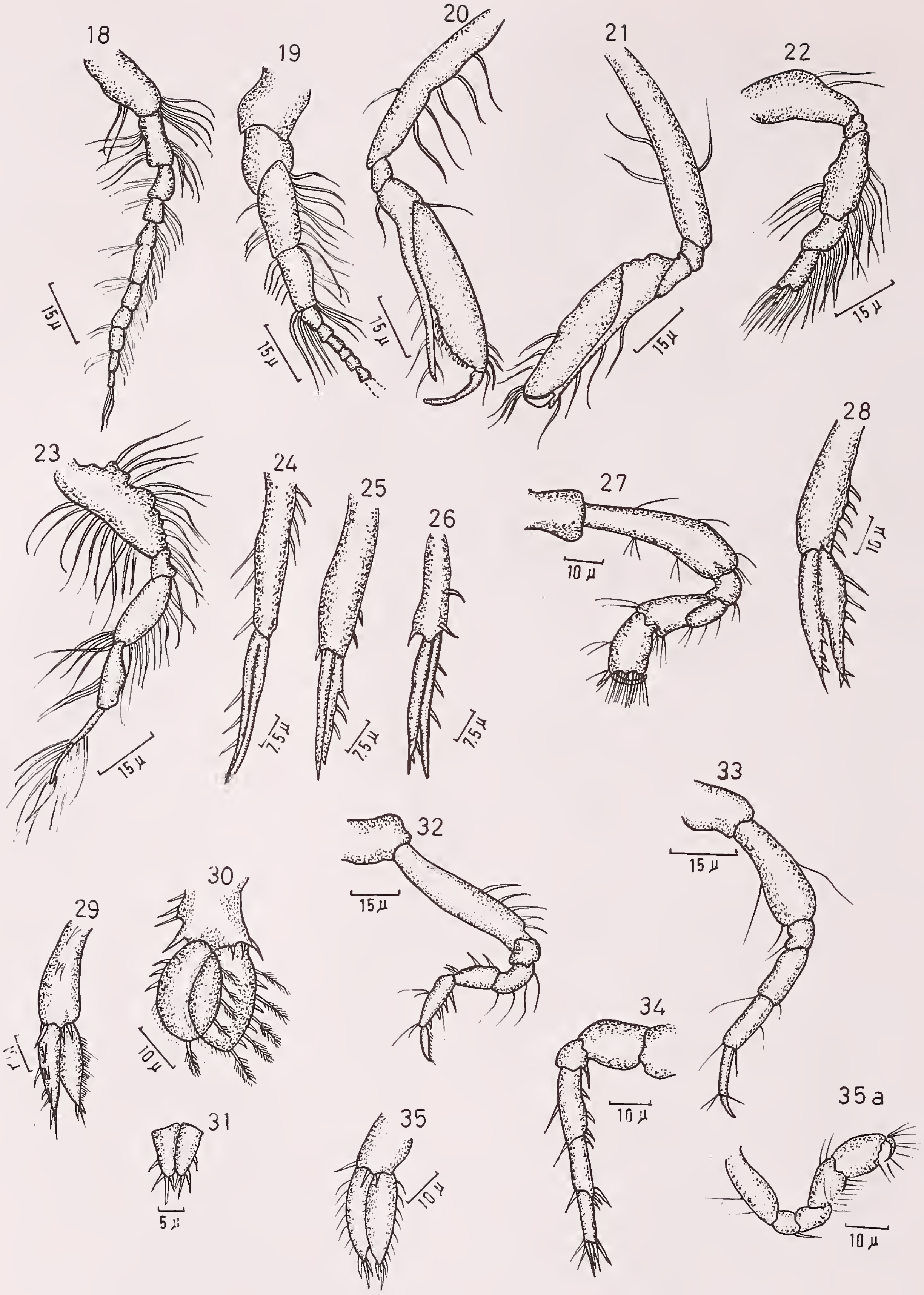
Figs. 1-10. *Ampelisca zamboangae* Stebbing: 1. Mandible; 2. Maxilla; 3. Maxilliped; 4. Gnathopod 1; 5. Peraeopod 1; 6. Peraeopod 4; 7. Peraeopod 5; 8. Uropod 1; 9. Uropod 2; 10. Telson.
Figs. 11-14. *Urothoe ruber* Giles: 11. Antenna; 12. Peraeopod 2; 13. Peraeopod 3; 14. Uropod 3 with telson.
Figs. 15-17. *Platyischnopus herdmanii* Walker: 15. Gnathopod 1; 16. Peraeopod 5; 17. Telson.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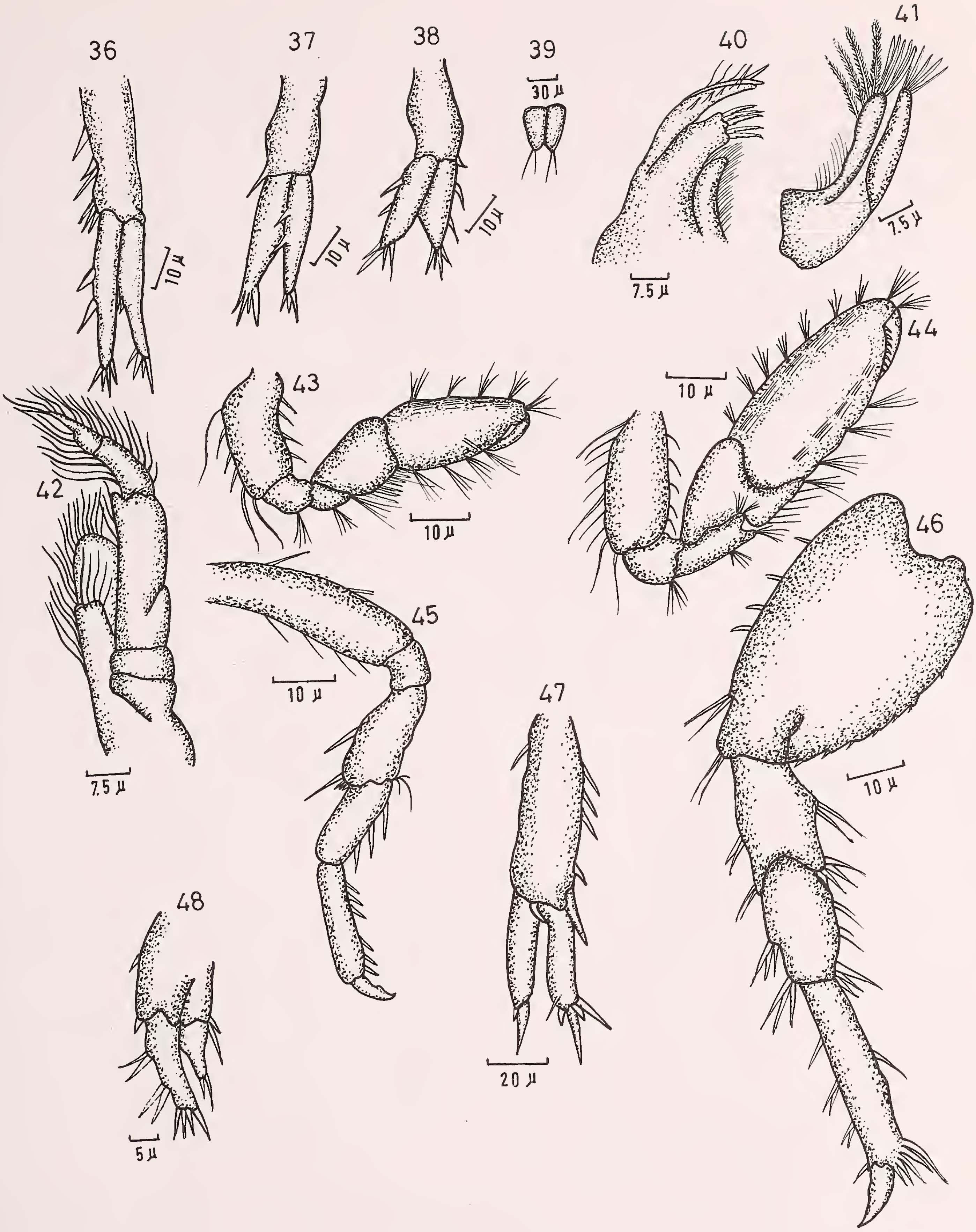
Figs. 18-26. *Perioculodes megapleon* (Giles): 18. Antennule; 19. Antenna; 20. Gnathopod 1; 21. Gnathopod 2; 22. Peraeopod 1; 23. Peraeopod 5; 24. Uropod 1; 25. Uropod 2; 26. Uropod 3.
Figs. 27-29. *Hornellia incerta* Walker: 27. Gnathopod 2; 28. Uropod 1; 29. Uropod 3.
Figs. 30-31. *Megaluropus agilis* Hoek: 30. Uropod 3; 31. Telson.
Figs. 32-35. *Pseudotiron brevidactylus* Pillai: 32. Gnathopod 2; 33. Peraeopod 2; 34. Peraeopod 5; 35. Uropod 3.
Fig. 35a. *Parelasmophus suluensis* Stebbing: Gnathopod 2.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Figs. 36-39. *Parelasmopus suluensis* Stebbing: 36. Uropod 1; 37. Uropod 2; 38. Uropod 3; 39. Telson. Figs. 40-48. *Elasmopus pectenicrus* (Bate): 40. Maxilla 1; 41. Maxilla 2; 42. Maxilliped; 43. Gnathopod 1; 44. Gnathopod 2; 45. Peraeopod 1; 46. Peraeopod 5; 47. Uropod 1; 48. Uropod 3.

Distribution: Sri Lanka, Arabian Sea and Bay of Bengal.

Genus *Megaluropus* Hoek

Megaluropus agilis Hoek

(Plate 2, Figs. 30-31)

First antenna as long as the peduncle of second antenna with a 10-jointed flagellum and 2-jointed accessory flagellum. Second antenna 13-jointed. Gnathopods as described by Stebbing (1906).

The second segment in the third, fourth and fifth peraeopods is expanded. Fifth peraeopod longer than the body. Seventh segment spine-like with plumose setae. All appendages setose, rami of the third uropod (Fig. 30) highly expanded, bearing scanty plumose setae. Telson cleft with rounded distal lobes (Fig. 31).

Length: 4.2 mm.

Occurrence: Lawson's Bay.

Distribution: Krusadai Island, Tamil Nadu, Port Blair, Andamans, Sri Lanka, South Africa, Mediterranean, North Sea.

Family Tironidae

Genus *Pseudotiron* Chevreux

Pseudotiron brevidactylus Pillai

(Plate 2, Figs. 32-35)

This species was first erected by Pillai (1957). It has a compressed body with a square head. First antenna with short accessory flagellum. Mandible without a palp; accessory plate with seven barbed spines. Outer lobe of first antenna has 9 spines. Inner lobe small and bears 5 teeth and 1 seta. Inner lobe of the second maxilla broader and slightly setose. The inner lobe of the maxilliped truncate with seven stiff setae.

Two gnathopods alike, with hook-like dactylus (Fig. 32). Third, fourth and fifth peraeopods with long spines (Figs. 33 and 34).

First and second uropods with spines. Tips of all rami with three spines each. The rami of third uropod slightly flattened, with long apical and short outer spines and plumose setae on the inner border (Fig. 35). Telson long, lanceolate, each lobe with a long apical spine.

Length: 3.5 mm.

Occurrence: Lawson's Bay.

Genus *Parelasmopus* Stebbing

Parelasmopus suluensis Stebbing

(Plate 2, Fig. 35a, Plate 3, Figs. 36-39)

Agrees in all essential details with the description given by Stebbing (1906). Pleon segments less massive. Fourth pleon segment bears large teeth, the lower border of third pleon segment has a single tooth. Male has a 3-jointed accessory flagellum. Gnathopods weak, fifth segment of second gnathopod longer than broad. The palmar border of sixth segment serrated (Fig. 35a). The apical spines of the first and second uropods (Figs. 36-38) are longer than in Stebbing's illustration. The apical lobe of the telson (Fig. 39) bears 3 spines.

Occurrence: Lawson's Bay.

Distribution: Maldive and Laccadive Islands and Bay of Bengal, Sri Lanka, Red Sea, East Africa. Australia.

Genus *Elasmopus* Costa

Elasmopus pectenicrus (Bate)

(Plate 3, Figs. 40-48)

Antenna 1 is half the length of the animal. Peduncle and flagellum of equal length. Peduncular joint subequal. Accessory flagellum 2-joined. Antenna 2 as long as the peduncle of antenna 1.

Inner lip with very small inner lobes. Fine setae present on the anterior margin of both the lobes. First maxilla (Fig. 40) with an outer and inner lobes and a palp. Maxilla 2 (Fig. 41) with inner plate heavily setosed. Outer lobe bears a number of apical setae (8-10). Maxilliped (Fig. 42) with a narrower inner and a broader outer lobe bearing long and slender setae around them. Second joint of palm reaches well beyond the outer lobe. The last joint of palp bears apically long and hairy setae.

Gnathopod 1 (Fig. 43) smaller, second joint long, fifth and sixth segments subequal in length, sixth with parallel sides. Finger slightly curved to fit the palm. Palm slightly oblique with a row of weak spines. The whole appendage is heavily setose on the margins.

Gnathopod 2 (Fig. 44) bigger than the first, second joint elongated, fifth joint slightly cup-shaped. Bands of setae present on the sixth article. Palm oblique, sixth segment with a row of curved teeth.

Peraeopods spinose, one and two alike (Fig. 45). Peraeopods 3, 4 and 5 (Fig. 46) characterised by the inferior margin of the second joint developed into a comb-like fringe. These peraeopods are armed heavily with spines.

Length: Female 3.8 mm; Male 4.2 mm.

Occurrence: Lawson's Bay.

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YELLOWTHROATED BULBULS AT HORSLEY HILLS[1]

S. SUBRAMANYA[2] AND J.N. PRASAD[3]

(*With a text-figure*)

Key Words: yellow throated bulbul, *Pycnonotus xantholaemus*, abundance, food, feeding habits, Horsley Hills

Yellowthroated Bulbul *Pycnonotus xantholaemus* was studied at Horsley Hills to gather details on its abundance, habits, food and feeding behaviour. Compared to other congeneric species, *P. xantholaemus* was the most abundant on the hills. The species occasionally moved in groups of six birds though pairs were more common. The diet of the species consisted of berries and insects. The birds adopted different methods to capture insects, though aerial feeding was most common. Aggressive interactions with conspecifics and other species were noticed. Though *P. xantholaemus* resembles *P. luteolus* closely with respect to certain habits and call notes, distinct differences were noticed.

INTRODUCTION

The Yellowthroated Bulbul *Pycnonotus xantholaemus* (Jerdon) is an endemic species, restricted to South India (Ali and Ripley 1987, Gaston 1984, Ripley 1955) and very little is known on its habits (Ali and Ripley 1987). Much of what is known on the habits of this species comes from the observations made at Horsley Hills by P. Roscoe Allen (1908). But for the observations of Ali (1942) which threw light on the habitat type and food habits, not much has been added to the knowledge of this species (Ali 1969, Ali and Ripley 1987, Baker 1922, 1932) since Allen (1908). In following up the observations of Roscoe Allen, we visited Horsley Hills between 17-20 October 1991 to add to the present knowledge of this species as part of our study on *P. xantholaemus* (Subramanya *et al.* 1990, 1991).

Though ornithologically, very little is known about Horsley Hills (e.g. Allen 1908), Whistler and Kinnear (1932) indicate that this may have possibly been the location where Jerdon (1863) obtained the type of specimen of *P. xantholaemus*. The two specimens from Horsley Konda (Horsley Hills) presently in the collection of Bombay Natural History Society (Abdulali 1982, BNHS reg. nos.: 2062 and 2063) are those collected by Roscoe Allen on 29 April and 22 May 1908, respectively.

STUDY AREA

Horsley Hills (13° 41' N, 78° 28' E), in Chittoor District of Andhra Pradesh, so named after Mr. M.W.H. Horsley, a member of Indian Civil Service of the erstwhile British Raj, is part of a range of hills in the Eastern Ghats. The presence of crude fortification vestiges, indicate that at one time, it had great local importance. Though the habitat is predominantly of dry deciduous type, a small patch of moist deciduous forest still exists. With the upgradation of its status as a hill resort, the developmental activities and a large scale *Eucalyptus* plantation in 1963 seems to have wrought changes to the habitat. In the areas around the habitations and along the road *Eucalyptus* has been planted in small patches. Whatever wild vegetation exists today is much disturbed. Though a meshed fence has been erected on either side of the road, villagers from neighbouring areas stray into the protected area for wood cutting and their cattle can also be seen frequenting the outer hills for grazing. However, good natural tree vegetation exists in places where the approach has been made inaccessible due to the dense growth of *Lantana*. In certain places, slopes are thickly covered with grass.

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METHODOLOGY

Horsley Hills was visited between 17-20 October 1991 and the hill area was traversed on foot and detailed notes were maintained on the relative abundance of all congeneric bulbuls seen, food and foraging habits, group size and other behavioural observations on *P. xantholaemus*.

RESULTS AND DISCUSSIONS

Relative Abundance of bulbuls: During the observation period, four species of bulbuls, namely *P. cafer, P. jocosus, P. luteolus* and *P. xantholaemus* were recorded. A total of 158 bulbuls were sighted. In their relative abundance of different *Pycnonotus* species, *P. xantholaemus* was the most abundant species, while *P. cafer* had the lowest relative abundance (Fig. 1). Several authors have considered (e.g. Allen 1908, Ali 1942, Ali and Ripley 1987, Baker 1922) *P. xantholaemus* to be an uncommon species, but as it can be seen from the relative abundances of the four congeneric species, its preferred habitat *P. xantholaemus* appears to be not so uncommon. Contrary to observation of Allen (1908), the species appears to be abundant not just towards the end of May, but throughout the year.

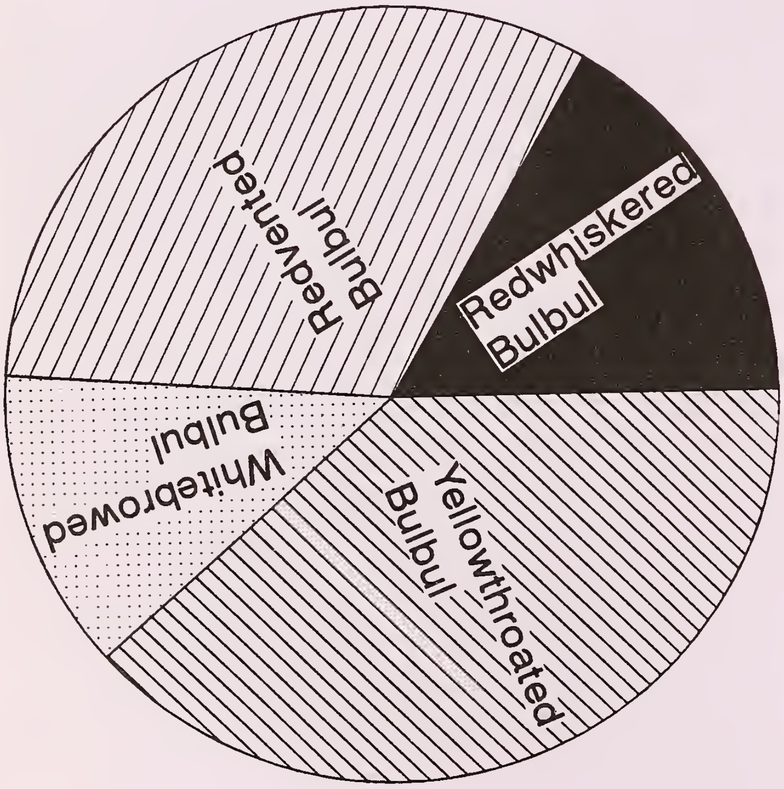

Fig. 1. Relative abundances of different species of bulbuls at Horsley hills. (17-20, October 1991; n=158).

Though *P. cafer* and *P. jocosus* were seen around human habitations, *P. luteolus* and *P. xantholaemus* were found away from human disturbed areas and in densely vegetated boulder strewn regions of the hills. The Mission bungalow environs where Allen (1908) obtained his first of the two specimens, is no longer a favourite haunt of *P. xantholaemus*. Though *Ficus* trees in fruit were found within the compound of the bungalow, where we stayed during the study, *P. xantholaemus* were not sighted anywhere close by.

Group Size: On the hills *P. xantholaemus* occurred either singly or in groups of six birds. However, pairs were more common. The larger groups observed could be family parties, as in one instance, one of the birds in a group of six were seen feeding the other one, which could have been its own offspring in a subadult stage. It is not known how long the offsprings stay with their parents after fledging.

Food and Feeding Habits: Both insects and berries were observed being taken by *P. xantholaemus*. Of these 34 instances observed, *P. xantholaemus* took insects nearly 53% of the time and the rest comprised of fruits.

Insects were either captured aerially by hovering or by making a short sortie from a branch, or by gleaning leaves or bark of the plants. While capturing insects, the bird hopped from one branch to the other. Before taking up the next position, it scanned the section of the plant below and around it in a manner typical of a Leaf Warbler — crouching close to the branch on which it had perched and bending its head down or by turning its head sideways. On sighting an insect, the bird hovered vertically for a short time in front of a leaf or cluster of leaves. On the other occasions, it readily launched itself into a short sortie to take the insect or picked up the insect from the leaf or bark surface.

On one occasion, an insect was captured by alighting on the ground and flying up a few inches to secure it. In all the cases observed, the prey captured were less than a centimetre in size, except once when about a three centimetre long caterpillar was gleaned from the bark. All successful insect captures ended with rubbing of the beak following feeding. Of the different methods adopted for capturing insects, flycatching was the most common method of insect capture by *P. xantholaemus*. However, this could very well be a seasonally induced behaviour owing to a preponderance of flying insects during our visit.

Once a pair of *P. xantholaemus* was observed foraging along with two *Terpsiphone paradisi,* two *Nectarinia lotenia, Prinia hodgsonii* and two *P. luteolus*. These birds were active in the canopy of a *Ficus* tree found amidst a dense growth of *Lantana.* When one of the authors (SS) approached the group to have a closer look, they moved away one after another into the dense canopy of a nearby tree instead of dispersing as expected, indicating that the pair was part of an active hunting party.

Only three types of fruits were observed being taken during our brief observation of which *Solanum indicum* made up nearly 61% of the fruits. *Ficus benghalensis, Santalum album* and *Zizyphus* were taken at a frequency of 22.2%, 11.1% and 5.6% respectively (n=18). Ali (1942) also obtained seeds of *Santalum* from the stomach of *P. xantholaemus* in Karnataka. Though *Solanum* berries with yellow, orange and red colours were available on the plant, the bulbuls were observed to select only the ripe red berries.

Interaction with conspecifics and other birds: During the study, *P. xantholaemus* were observed either chasing their conspecifics or other birds like *P. jocosus* and *Phylloscopus trochiloides.* Also, once a *P. luteolus* was also seen chasing a *P. xantholaemus* from a bush. Chasing of conspecifics occurred only in larger groups.

Chasing of other birds by *P. xantholaemus* seems to indicate resource defence behaviour as strong evidence of chasing *P. trochiloides.* This behaviour seems to indicate that *P. xantholaemus* does not tolerate competing species whether for food or for other resources. The single instance of *P. xantholaemus* being chased by *P. luteolus* seem to indicate that the bulbuls (*Pycnonotus* species) defend locally established feeding territories. Instances of chasing each other while feeding within a group of *P. xantholaemus* probably indicate the presence of intraspecific competition which may act as precursor, a prelude to the breaking up of family groups in the post-breeding season.

At one of the observation sites, a radius of 20 m area was shared by one *P. cafer,* two *P. jocosus,* one *P. luteolus* and six *P. xantholaemus.* Though other species moved about a great deal, the movement of *P. xantholaemus* was much restricted and for about 45 minutes, they moved among a few selected trees and bushes within a radius of about 5 m. This area contained *Solanum indicum, Santalum album* and *Zizyphus* sp. which were in fruit and a three metre tall *Vitex* sp. in which a majority of the insects were captured.

Other Observations: Compared to *P. jocosus* which was distinctly arboreal and occupied perches from less than a metre in height to those about 30 m, all the movements of *P. xantholaemus* were restricted to less than 10 m from the ground. Here again, the activity was centred around spots with dense bushes, trees with large canopy and boulders. Allen (1908) indicates the species to be less shy and more arboreal than *P. luteolus.* It was observed that while in flight, the species often flies well clear of the tree tops and invariably flies into bushes or trees. When not disturbed, the birds were observed to perch openly on top of large boulders.

The call notes of this species can easily be mistaken for those of *P. luteolus* but with little experience, the chucklings of *P. xantholaemus* can be told apart as being less harsh and mellower than that of *P. luteolus* (see Subramanya *et al.* 1991).

ACKNOWLEDGEMENTS

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NEW DESCRIPTIONS

A NEW SPECIES OF *AGIOMMATUS* CRAWFORD (HYMENOPTERA: PTEROMALIDAE) — AN EGG PARASITE OF A CUTWORM ON MULBERRY IN BANGALORE (KARNATAKA)[1]

P.M. Sureshan[2] and T.C. Narendran[3]

(*With five text-figures*)

A new species of Pteromalidae, namely *Agiommatus geethae* parasitising eggs of *Spodoptera litura* (Fab.) on mulberry is described from Bangalore (Karnataka). A key to the species of *Agiommatus* is also provided.

Introduction

In this paper we have described a new species of *Agiommatus* Crawford (Hymenoptera: Pteromalidae) parasitising the eggs of *Spodoptera litura* (Fab.). Besides this new species from Bangalore, only three species of the genus, namely *A. sumatraensis* Crawford, 1911 from Sumatra, *A. attaci* Ferriere, 1930 from Malay peninsula and *A. paria* (Motschulsky) 1863 from Sri Lanka and India are so far known from South Asia.

Agiommatus geethae sp. nov.

(Figs. 1-5)

FEMALE: Length 1.9 mm. Body dark metallic blue, almost black on lateral part of head and thorax; gaster including petiole brownish black, pale ventrally; eyes dark cupreous; ocelli brown. Antennae with scape, pedicel and anelli pale yellow, remainder pale brownish yellow. Legs yellow with fore and hind coxae almost brown; mid coxae pale brownish yellow; tips of tarsi brown.

Head (Figs. 1, 3 & 4): Uniformly and finely reticulate, with sparse white pubescence. In dorsal view head width 1.7 x length and in front view width 1.3 x height; temple length 0.4 x eye length; POL 3 x OOL; ocell-ocular area slightly depressed; clypeus angularly projecting with anterior edge deeply emarginate; malar space length 0.5 x eye length; malar grooves distinct; eye length 1.4 x width in profile. Antennae (Fig. 2) inserted below middle of face; scape length 0.6 x eye length; third anellus slightly longer than other two; club longer than two preceding segments combined.

Thorax (Fig. 1): Moderately reticulate, covered with sparse white pubescence; pronotal edge rounded without carina. Mesoscutum with notauli incomplete, fading towards the posterior end, width 2 x length, lateral lobe with a distinct fovea in lateral corner at tegula and another at outer corner of axilla. Scutellum with reticulation finer on frenal area, almost as long as wide. Propodeum width 2.3 x median length; median carina and costula distinct; nuchal area almost shiny; plicae distinct; spiracles elongatedly oval; callus with few scattered hairs. Prepectus very small, almost smooth. Mesopleuron slightly elevated making the lateral panel of pronotum little low, with the anterior face separated by a fine epicneminal carina. Mesepisternum moderately reticulate. Upper mesepimeron smooth and shiny, lower part separated by a deep pit. Metapleuron very finely reticulate. Fore wing (Fig. 5) length 2 x width, basal part almost bare with few setae on basal vein; mv slightly thickened uniformly. Relative lengths of smv, mv, pmv, and stv as 14, 10, 6.5 and 4. All coxae smooth. Relative lengths of hind coxa, femur, tibia and tarsus as 5.5, 10.5, 12.5, and 10.

Gaster (Fig. 1): Elongatedly ovate; petiole length 2 x width, little shorter than hindcoxa; gaster length 2.8 x width in dorsal view; T1 angulate in the middle; T2 deeply emarginate in the middle at posterior end; T3 largest; ovipositor sheaths not protruding out.

MALE: Not known.

Host: Eggs of *Spodoptera litura* (Fab.)on mulberry.

Holotype: FEMALE: INDIA; Karnataka: Bangalore, 30.ix.1994, Coll. Geetha bai, ex. cutworm eggs on mulberry.

Paratypes: 10 Females, data same as that of holotype. The type specimens are kept in the collections of Zoological Survey of India, Western

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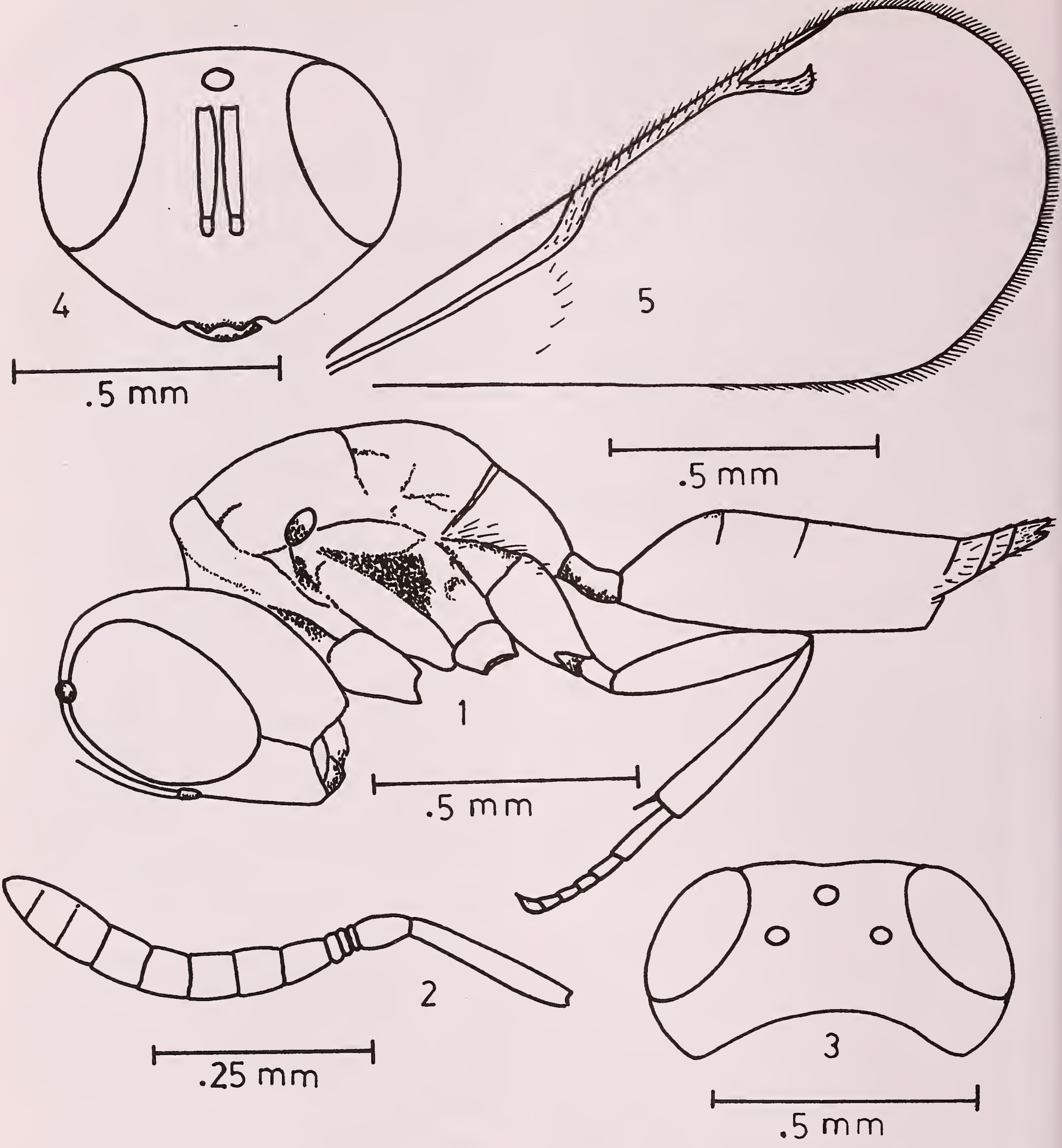

Figs. 1-5. *Agiommatus geethae* sp. nov. Female: 1. Body in profile; 2. Antenna; 3. Head in dorsal view; 4. Head in front view; 5. Forewing.

Ghats Field Research Station, Calicut but eventually will be deposited in the National Zoological Collections of Zoological Survey of India, Calcutta.

Etymology: The species is named after Dr. (Mrs) Geetha Bai, Scientific Officer, Karnataka State Sericulture Development Institute, Bangalore who was kind enough to send the specimens for our studies.

Remarks: The species closely resembles *A. paria* (Motschulsky) but differs from it as follows: (1) gaster without yellow transverse stripes between T1 & T2 and T3 & T4, ventral side not yellow; legs with forecoxae almost entirely and basal two third of hind coxae brown [in *paria,* gaster with yellow transverse stripes between T1 & T2 and T3 & T4, ventral side almost entirely yellow; base of fore and hind coxae greenish]; (2) antennae with pedicel distinctly longer than wide (2 x), club 1.4 x greater than two preceding segments combined [in *paria,* antennae with club as long as two preceding segments combined, pedicel a little longer than wide]; (3) mesoscutum only 2 x as wide as long with parapsidal furrows indicated clearly up to an area just above posterior margin [in *paria,* mesoscutum more than twice as wide as long with parapsidal furrows only anteriorly weakly inpressed]; (4) length varies between 1.8-1.9 mm [in *paria,* length between 2.3-2.5 mm].

KEY TO THE SPECIES OF *Agiommatus* CRAWFORD MODIFIED FROM FERRIERE (1931) AND MANI (1989)

1. Anterior coxae with a distinct spine in front; legs including coxae entirely whitish yellow; size 2.25 mm. Host: eggs of *Erionota thrax* (L.) Sumatra .... *sumatraensis* Crawford

— Anterior coxae without spine in front; legs with coxae not entirely whitish yellow; size 1.8-3.5 mm 2

2. Antenna (fig. 2) with club 1.4 x as long as two preceding segments combined; gaster without yellow transverse stripes; parapsidal furrows indicated clearly up to an area just above posterior margin of mesoscutum; forecoxae almost entirely and two-third portion of hindcoxae brown. Size 1.8-1.9 mm; Host: eggs of *Spodoptera litura* (Fab.). India: Karnataka .... *geethae* sp. nov.

— Antennae with club as long as two preceding segments combined; gaster with two yellow transverse stripes; mesoscutum with parapsidal furrows only anteriorly impressed or reaching up to the middle; base of anterior and posterior coxae greenish. Size 2.3-3.5 mm 3

3. Antennae with F1 twice as long as wide, the succeeding segments gradually shorter but longer than wide; mesoscutum with parapsidal furrows weak and reaching up to the middle; legs whitish, anterior and posterior coxae completely green. Size 3-3.5 mm. Host: eggs of *Attacus atlas* L. Malay peninsula (Kuala Lumpur, Java) .... *attaci* Ferriere

— Antennae with F1 a little longer than wide, others shorter, 4th and 5th quadrate; mesoscutum with parapsidal furrows only anteriorly weakly impressed; legs more yellowish, only the base of anterior and posterior coxae green. Size 2.3-2.5 mm. Host: eggs of *Acherontia styx* Westwood. Sri Lanka, India .... *paria* (Motschulsky)

ACKNOWLEDGEMENTS

One of us (PMS) is grateful to the Director, Zoological Survey of India, Calcutta and the Officer-in-charge, Zoological Survey of India, Western Ghats Field Research Station, Calicut for providing facilities and encouragement. We are also thankful to Dr. (Mrs) Geetha Bai, Scientific Officer, Karnataka State Sericulture Development Institute, Bangalore for providing the specimens for our studies and the authorities of the University of Calicut, Kerala for the facilities provided.

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CROSSOCHEILUS PERIYARENSIS, A NEW CYPRINID FISH FROM THANIKKUDY (THEKKADY), KERALA, INDIA[1]

A.G.K. MENON[2] AND P.C. JACOB[3]

(*With a plate*)

Crossocheilus periyarensis is described as a new species of Cyprinid fish from the Periyar River of the High Ranges of the Western Ghats of Kerala State, South India, from four specimens. It is characterised as follows: 8 branched rays in the dorsal fin, 34-36 scales on lateral line, 4.5 series of scales from origin of dorsal to lateral line and 3.5 between lateral line and origin of pelvic fin, 15-17 gill rakers on the first arch, a pair of rostral and maxillary barbels and prominent horny tubercles on the snout and cheek in the males, upper half of body brownish black, lower yellowish, dorsal and caudal fins yellowish grey, the other fins clear. No lateral stripe or black spot on caudal base as in *C. latius latius*.

INTRODUCTION

Three genera of the subfamily Cyprininae occur in South and South-eastern Asia, *Crossocheilus* Kuhl and Van Hasselt in Van Hasselt, 1823, *Epalzeorhynchos* Bleeker, 1855, and *Paracrossocheilus* Popta, 1904, characterised by having the upper lip coalescent with the skin of the snout (not separated from the snout as in most other cyprinids) and crenulated. These three genera are, therefore, grouped into the *Crossocheilus* group (Banarescu 1986). Of these genera, *Epalzeorhynchos* differs from *Crossocheilus* in having a pair of movable, stiff lobes on the sides of the snout (Weber and de Beaufort 1916, Smith 1945) and a narrow frenulum connecting both lips. In *Crossocheilus*, the narrow frenulum connects the upper lip with the lower jaw, not the lower lip. *Paracrossocheilus* differs from both in having the lips continuous at the corners instead of the lips being connected by a narrow frenulum as in *Crossocheilus*.

In addition to the new species described here, the following eight species and subspecies of *Crossocheilus* are recognised: 1. *C. cobitis* (Bleeker, 1860); 2. *C. gnathopogon* W. and de Beaufort, 1916; 3. *C. horai* Banarescu, 1986; 4. *C. langei* (Bleeker, 1860); 5. *C. latius latius* Hamilton, 1822; 6. *C. latius diplocheilus* (Heckel, 1853); 7. *C. oblongus* (Valenciennes, 1842) and 8. *C. reticulatus* (Fowler, 1934).

In the course of our studies of the fishes of Periyar River in Kerala State, South India, four adult male specimens of *Crossocheilus* were obtained which are distinct from all the so far known species of the genus. It is described here as a new species.

MATERIAL AND METHODS

The material examined in this study consists of four specimens measuring 98.0 to 131.0 mm SL collected by cast net in the fast flowing Periyar at Thanikkudy, about seven km above the Thekkady Lake. The description is based on measurements with dial calipers with an accuracy of 0.02 mm. Data are presented as percentages of SL and HL, with the range followed by the mean in parentheses.

Crossocheilus periyarensis sp. nov.

Diagnosis: A species of *Crossocheilus* having 8 branched rays in the dorsal fin, 34-36 scales in lateral line, 15-17 gill-rakers on the first arch, both pair (rostral and maxillary) of barbels and horny tubercles on the snout and cheek in the males.

Holotype: SRS/ZSI (Southern Regional Station of Zoological Survey of India) No. F. 3508,

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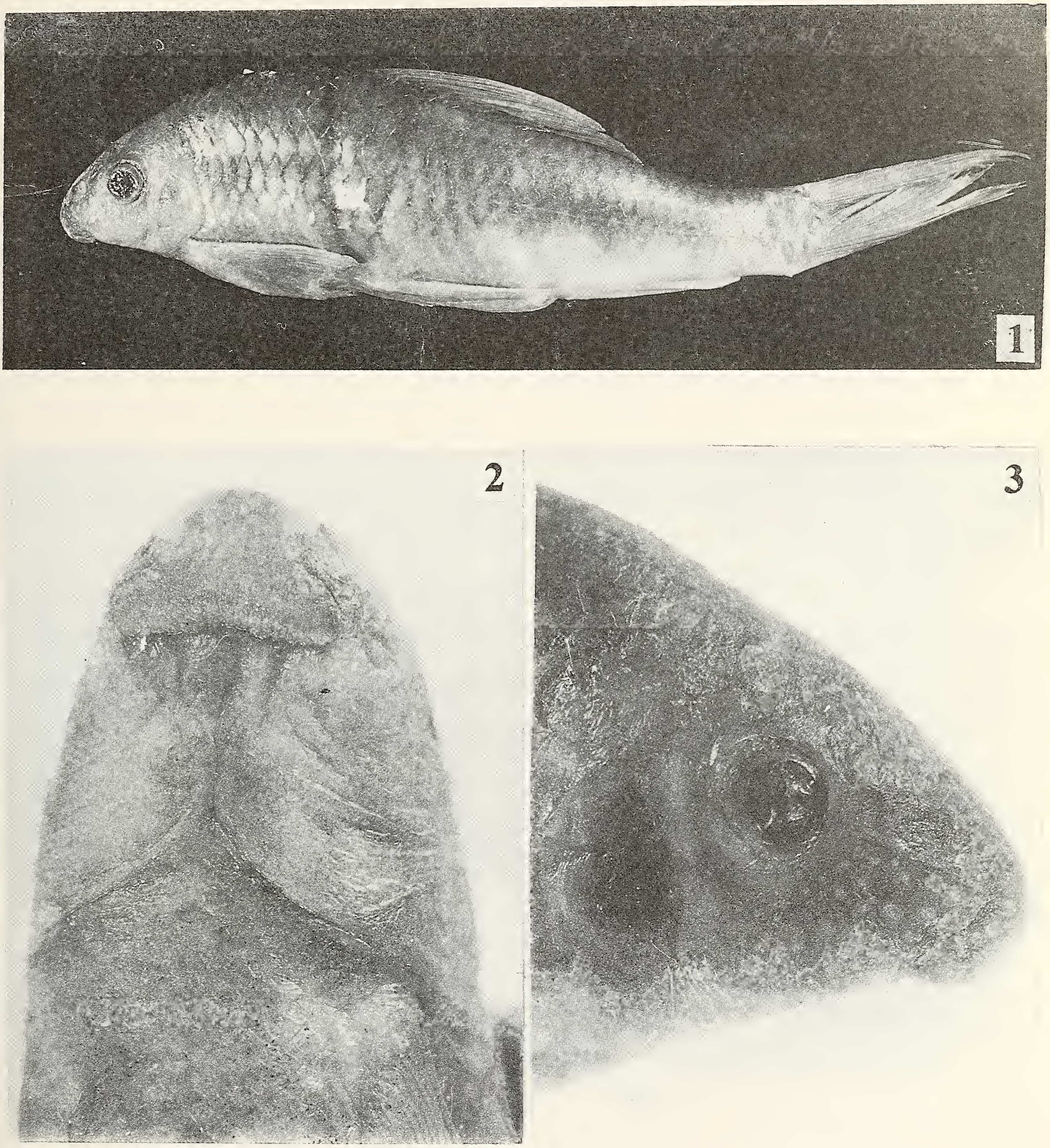

Figs. 1-3. *Crossocheilus periarensis* sp. nov.
1. Lateral view (98.0 mm SL); 2. Ventral view of mouth, enlarged; 3. Lateral view of head, enlarged.

131.0 mm SL, Periyar river, Thanikkudy (Thekkady), Kerala State, South India, collected by P.C. Jacob, October, 1990.

Paratypes: 3 specimens, SRS/ZSI No. F. 3509, 98.0 to 115.0 mm SL, same data as holotype.

Description: Based on 4 specimens (holotype and 3 paratypes) D.3/8, A.3/5, P.1/12, V.1/7, L.1. 34-36, Ltr. 5/1/5, Phar. Teeth 5.4.2/2.4.5.

Body moderately elongate, somewhat compressed, dorsal and ventral profiles convex. Depth of body 24.5-27.5 (M=25.6)% SL, length of head 19.1-20.2 (M=19.6). Snout obtusely rounded with prominent nuptial tubercles developed in males, densely covering on snout and cheek, its length 8.8-10.4 (M=9.8)% SL, 45.0-54.5 (M=50.5)% HL. Eye shorter than snout, its diameter 20.3-27.5 (M=24.8)% HL and 45.8-68.7 (M=56.4)% interorbital width. Paired rostral and maxillary barbels, the rostral ones longer but much shorter than eye, its length 11.1-15.0 (M=12.6)% HL. Mouth wide, covered by the papillated upper lip, lower lip fleshy, without post-labial groove and not connected with the upper lip at corners.

Caudal peduncle length 18.6-20.4 (M=19.3)% SL; its least height 59.1-68.7 (M=63.3)% HL, 50.0-55.0 (M=53.0)% of its own length.

Squamation: Tube-bearing scales on lateral line 34 to 36, scales in transverse series from midline of back to abdomen 5/1/5 with 4.5 series from origin of dorsal to lateral line and 3.5 between lateral line and origin of ventral fin, predorsal scales 12, circumpeduncular scales 13-14.

Fins: Dorsal origin much nearer to tip of snout than to base of caudal, over 8th scale of lateral line: dorsal margin of fin concave, its height more than length of head, 23.5-27.5 (M=25.8)% SL; anal origin opposite 20th scale of lateral line, its longest branched ray 22.2-31.5 (M=27.7)% HL. Pectoral and pelvic fins subequal, slightly smaller than head, length of pectoral 16.4-20.9 (M=18.8)% SL. Pelvic origin under 11th scale of lateral line, length of ventrals 17.6-21.4 (M=19.1)% SL. Caudal deeply forked, longer than head, lobes pointed. Pre-dorsal distance 41.4-44.1 (M=42.7)% SL, pre-pelvic distance 43.3-47.1 (M=45.1), pectro-pelvic distance 24.4-30.3 (M=27.2), pelvic-anal distance 22.0-24.5 (M=23.5).

Body completely covered with moderately large scales except on the chest which is covered by smaller scales. The focal zone of scale is eccentric and the upper part of posterior side of scales is thickly pigmented.

Etymology: Named after the Periyar River in which it occurs.

Coloration: Upper half of body brownish black, lower yellowish, no lateral stripe or black spot on caudal base as in *Crossocheilus latius,* fins clear, the dorsal and caudal fins yellowish grey.

Distribution: Known only from the Periyar drainage at Thanikkudy, Kerala, South India.

Remarks: Geographically, the closest relative of *Crossocheilus periarensis* appears to be *C. latius latius* Hamilton which is known from the Eastern Himalayas (Ganges and Brahmaputra drainages), Orissa (Mahanadi drainage) and the Bombay Ghat portion of Western Ghats (Krishna drainage). Like *C.l. latius* it has 8 branched rays in the dorsal fin and both pairs (rostral and maxillary) of barbels but there is no similarity in colour and nuptial tubercles on the snout and cheek present in the males of *C. periyarensis.*

Hora (1937, 1950) has shown the occurrence in south-western India, especially in the rivers of the Western Ghats, of a number of freshwater fishes closely related to Eastern Himalayas, Indo-China and the Indonesian Archipelago.

The origin of *Crossocheilus* seems to be in South China, most probably Yunnan from where it had spread westwards along the Himalayas as far as Seistan and Afghanistan during the Pliocene and southwestward to the Indian Peninsula and southward to the Indonesian Archipelago during the Pluvial periods of the Pleistocene (Menon 1973).

The Poona population of *Crossocheilus* with a reduced number of scales along the lateral line (37-39 as opposed to 39-41 in *C. latius*) seems to be a distinct species evolved in the Deccan Plateau of the Indian Peninsula from the same Pleistocene stock that gave rise to *periyarensis* in the Periyar drainage.

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We express our gratitude to Mr. J.K. Tiwari, Conservator of Forests (Wildlife), Government of Kerala at Periyar Wildlife Sanctuary at Thekkady for the generous help rendered to our ichthyological survey of the Periyar river. We are also thankful to Drs. Petru M. Banarescu and Tyson Roberts for going through the manuscript and suggestions given for its improvement.

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ADDITION OF THREE NEW SPECIES OF *CHALCOLEPIS* CANDEZE (COLEOPTERA, ELATERIDAE: HEMIRRHIPINAE) TO THE INDIAN FAUNA[1]

PUNAM[2], L.K. VATS[3] AND M.S. SAINI[2]

(*With twelve text-figures*)

To the previously recorded three Indian species of genus *Chalcolepis* Candeze, three are added. Described and illustrated as new are *C. nigrimaculatus*, *C. truncatus* and *C. emarginatus*. A dichotomous key is provided for all Indian species of this genus.

INTRODUCTION

Erected by Candeze (1857), the genus *Chalcolepis* remained unreported from the Oriental region, till 1992, when Vats & Kashyap described three new species *C. pannus, C. rotundoextremus* and *C. kashyapi,* from India. Candeze established this genus with *C. luczoti* as its type species from Neotropical region. In the present text three more species are added from the Indian region. Holotypes will be submitted to Indian Agricultural Research Institute, Pusa National Collections, Division of Entomology, New Delhi.

This genus is based on a combination of some significant characters which include: Body covered with scales of different colours, with or without distinct patches; antennal segment 2 shorter than 3; elytra truncate at posterior extremities; tarsi furnished below with brushes of hairs; claw simple with setae at base; aedeagus longer than parameres, and parameres simple with or without subapical processes.

KEY TO INDIAN SPECIES OF GENUS *Chalcolepis* CANDEZE

1. Body covered with scales of three colours intermingled irregularly, with or without prominent patches 2
— Body covered with scales of two colours intermingled irregularly, with prominent patches 4
2. No distinct patches of scales present 3
— Distinct patches of black coloured scales present .... *nigrimaculatus* sp.nov.

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3. Mandibles dented; two depressions on either side of the middle of pronotum and a transverse ridge interrupted in middle on the posterior half present; posterior angles almost parallel; prosternal spine canaliculate between coxae; elytra rounded at extremities; last sternite of abdomen without any fossae .... *rotundoextremus* Vats & Kashyap

— Mandibles simple; pronotum without any depression and transverse ridge, but a pair of patches of black scales in the middle; posterior angles divergent; prosternal spine depressed between coxae; elytra truncated at extremities; last sternite of abdomen with two deep fossae posteriorly .... *kashyapi* Vats & Kashyap

4. Body covered with prominent patches of brownish and blackish scales; metabasitarsus shorter than following 2 joints combined as 6:7 .... *pannus* Vats & Kashyap

— Body covered with prominent patches of whitish and blackish scales; metabasitarsus equal to following 2 joints combined 5

5. Pronotum with a small median longitudinal line; posterior angles rounded; anterior margin of scutellum broadly emarginate; claw with a group of setae at base; head with dense, hexagonal punctation .... *emarginatus* sp.nov.

— Pronotum without any longitudinal line; posterior angles pointed; anterior margin of scutellum truncate; claw with a seta at base; head with scattered, rounded punctation .... *truncatus* sp. nov.

Chalcolepis nigrimaculatus sp.nov.
(Figs. 1, 3, 6, 8, 11)

Description.-*Colour*: Body black. Antenna and legs fuscous. Measurements: Body length = 29 mm, width == 7.5 mm; head length = 2.25 mm, width = 2.75 mm; antenna = 6 mm, 2nd segment = 0.3 mm, 3rd segment = 0.5 mm, 4th segment = 0.6 mm, last segment = 0.62 mm; thorax length = 8 mm, width = 7.5 mm; elytra = 18 mm.

Structure: Body width more than 0.25 x its length. Head flat with broad medial longitudinal depression, broader than long as 11:9; antenna reaching the middle of pronotum, 3rd segment longer than 2nd as 5:3 but shorter than 4th as 5:6; mandibles simple; labrum entire. Pronotum convex, longer than broad as 6:5, with a transverse ridge on the middle posteriorly and two shallow foveae one on each end of the ridge, and with medial longitudinal carina except anterior and posterior ¼ (Fig. 1); posterior angles rounded, short, carinate, carinae small; lateral sides of prothorax almost parallel; prosternopleural suture concave, opened anteriorly; prosternal spine rounded, straight with apex slightly declined, margined, abruptly narrowing at base (Fig. 6). Metasternum truncate between mesocoxae. Scutellum flat, longer than broad as 3:2, anterior margin with slight median notch, posterior margin arcuate (Fig. 8). Elytra convex, 2.25 x prothorax length, truncated at extremities, angles rounded, striae distinct. Claw simple with a seta at base (Fig. 11). Metabasitarsus longer than following 2 joints combined as 6:5.

Sculpture: Head with double, moderate, large, rounded punctation intermingled with dense fine rounded ones; pronotum with double, dense, small, hexagonal punctation intermingled with minute rounded ones; propleurae with double, dense, large, hexagonal punctation; prosternum with double, sparse, large, rounded punctation; elytral striae with deep, distinct, rounded punctation; interstriae with simple, dense, fine, rounded punctation.

Pubescence: Body covered with dense, scales of three colours; whitish yellow scales intermingles with brownish scales without distinct patches but blackish scales constitute distinct patches; a pair of elongated patches, one each on lateral side in the middle of pronotum (Fig. 1) and a pair of inverted 'C'-shaped patches one on each extreme lateral margin in the middle of elytra (Fig. 3).

Male genitalia: Male not found.

Material examined: Holotype: Female, Assam, Jatinga, 750 m, 25.5.1994. Paratype: 1 female, with same data as holotype.

Distribution: INDIA: Assam.

Diagnostic combinations: Body covered with scales of three colours which are irregularly intermingled with each other, and the presence of distinct patches of black coloured scales on pronotum and elytra, are the significant characters which distinctly separate *C. nigrimaculatus* from other Oriental species of this genus.

Etymology: Species name pertains to black spots present on elytra and prothorax.

Chalcolepis emarginatus sp.nov.
(Figs. 5, 10, 12)

Description: *Colour*: Body, black. Antenna and legs fuscous.

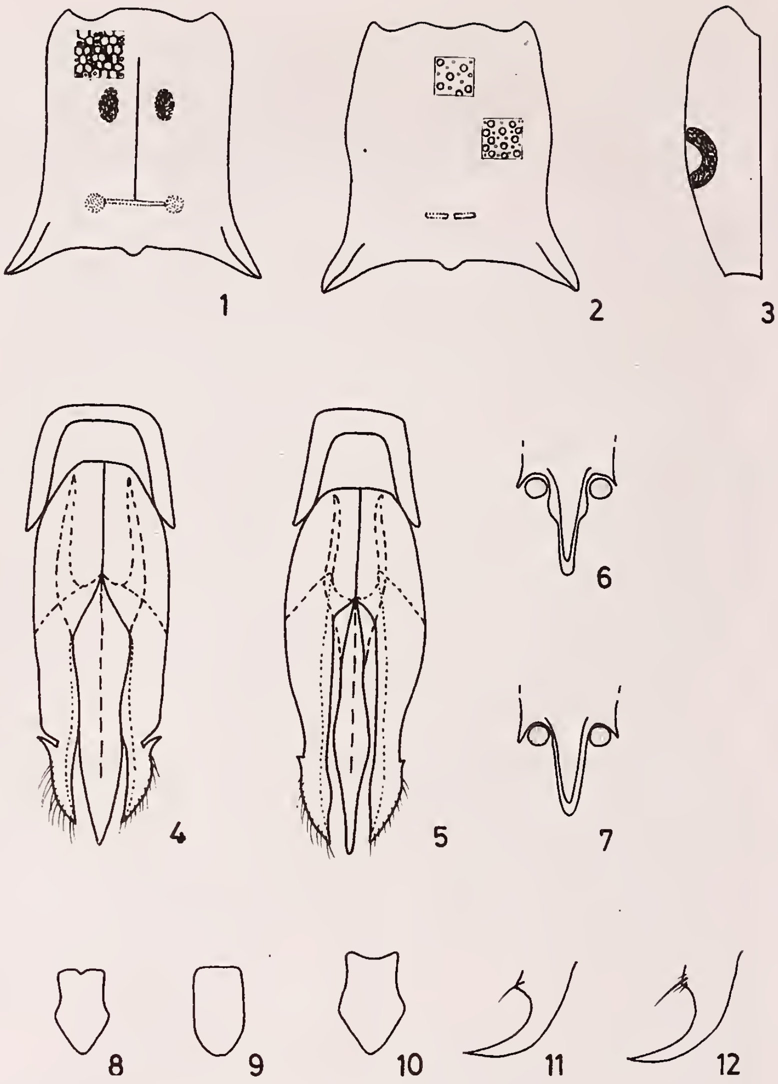
Measurements: Body length = 33 mm; width = 8.5 mm; head length = 3 mm; width = 3.25 mm; antenna = 7.5 mm; 2nd segment = 0.2 mm; 3rd segment = 0.5 mm; 4th segment = 0.6 mm; last segment = 0.75 mm; thorax length = 9 mm; width = 8.5 mm; elytra = 20.5 mm.

Structure: Body width more than 0.25 x its length. Head flat, with broad medial shallow depression, broader than long as 13:12; antenna extending beyond the middle of pronotum, 3rd segment longer than 2nd as 5:2, but shorter than 4th as 5:6; mandibles simple, labrum entire. Pronotum convex, longer than broad as 18:17, with a broken transverse ridge on the middle posteriorly and with a small median longitudinal line; posterior angles short, rounded, carinate, carinae small; lateral sides of prothorax subconvex; prosternopleural suture almost straight, opened anteriorly; prosternal spine rounded, straight with apex slightly declined, margined, gradually narrowing at base. Metasternum truncate between mesocoxae. Scutellum flat, longer than broad as 4:3, anterior margin broadly emarginate, posterior margin arcuate (Fig. 10). Elytra convex, 2.27 x prothorax length, truncated at extremities; striae distinct. Metabasitarsus equal to following 2 joints combined. Claws simple with a group of setae at base (Fig. 12).

Sculpture: Head with double, dense, small hexagonal punctation intermingled with dense, fine, rounded ones; pronotum with double, moderate, rounded punctation; propleurae with double, dense, large, rounded punctation; prosternum punctated like propleurae; elytral striae with simple, small, shallow, moderate punctation; interstriae with deep, distinct punctation intermingled with cross-striations.

Pubescence: Body covered with scales of two colours with distinct patches of whitish and blackish scales.

Male genitalia (Fig. 5): Phallobase with anterior margin truncate. Parameres with lateral sides medially convex and abruptly narrowing posteriorly; subapical processes long, inner lateral margins convex, outer lateral margin convex with minute anterior spine, Aedeagus slightly longer than parameres, swollen in middle and gradually tapering posteriorly into rounded tip; furcae long, ending just before anterior margin of parameres.



Figs. 1-2. Pronotum: 1. *Chalcolepis nigrimaculatus*, 2. *C. truncatus*; Fig. 3. Elytra of *C. nigrimaculatus*; Figs. 4-5. Male genitalia: 4. *C. truncatus*, 5. *C. emarginatus;* Figs. 6-7. Prosternal spine: 6. *C. nigrimaculatus*, 7. *C. truncatus*; Figs. 8-10. Scutellum: 8. *C. nigrimaculatus*, 9. *C. truncatus*, 10. *C. emarginatus*; Figs. 11-12. Tarsal claw: 11. *C. nigrimaculatus*, 12. *C. emarginatus*.

Material examined: *Holoytype* Male, Assam, Jatinga, 750 m, 15.9.1994. *Paratype* 1 male with same data as for holotype.

Distribution: INDIA: Assam.

Diagnostic combinations:.- Characters separating *C. emarginatus* from its allied species *C. truncatus* are discussed under the latter.

Etymology: Species name pertains to emarginate anterior margin of scutellum.

Chalcolepis truncatus sp.nov.

(Figs. 2, 4, 7, 9)

Description: *Colour*: Body black. Antenna and legs fuscous.

Measurements: Body length = 27.5 mm, width = 7 mm; head length = 2.5 mm, width = 2.5 mm; antenna = 6.5 mm, 2nd segment = 0.2 mm, 3rd segment = 0.4 mm, 4th segment = 0.7 mm, last segment = 0.8 mm; thorax length = 7.5 mm, width = 7 mm; elytra = 17.5 mm.

Structure: Body width more than 0.25 x its length. Head flat, with broad medial longitudinal concavity, inclined, as long as broad; antenna extending beyond the middle of pronotum; 3rd segment longer than 2nd as 4:2, but shorter than 4th as 4:7; mandibles simple; labrum entire. Pronotum convex with a broken transverse ridge on the middle posteriorly (Fig. 2), longer than broad as 15:14; posterior angles short, pointed, carinate, carinae very short; lateral sides of prothorax subconvex; prosternopleural suture straight, opened anteriorly; prosternal spine rounded, straight with apex slightly declined, margined, gradually narrowing at base (Fig. 7). Metasternum truncate between mesocoxae. Scutellum flat, longer than broad as 5:4, anterior margin truncate, posterior margin arcuate (Fig. 9). Elytra convex, 2.33 x prothorax length, truncated at extremities, angles pointed; striae deep, distinct. Claw simple, with a seta at base. Metabasitarsus equal to following 2 joints combined.

Sculpture: Head with double, scattered, small, rounded punctation intermingled with dense, fine, rounded ones; pronotum with double, sparse in middle but moderate on rest of surface, rounded punctation intermingled with minute, rounded punctation (Fig. 2); propleurae with simple, scattered, large, rounded punctation; prosternum punctated like propleurae; elytral striae with simple, deep, distinct, squarish punctation; interstriae with dense, fine punctation intermingled with cross-striations.

Pubescence: Body covered with scales of two colours with prominent patches of whitish and blackish scales.

Male genitalia: Fig. 4. Phallobase with anterior margin truncate. Parameres with lateral sides almost parallel; subapical processes long, inner lateral margins concave, outer lateral margin convex with long anterior spine. Aedeagus slightly longer than parameres, almost gradually narrowing into pointed tip posteriorly except for broad medial constriction; furcae long, ending just before anterior margin of parameres.

Material examined: *Holotype* Male, Assam, Jatinga, 750 m, 20.9.1993.

Distribution: INDIA: Assam.

Diagnostic combinations: A combination of some significant characters distinguishes *C. truncatus* from its allied species *C. emarginatus* which include: posterior angles pointed (rounded in *emarginatus*); anterior margin of scutellum truncate (emarginate in *emarginatus*); claw with a seta at base (a group of setae in *emarginatus*); head with scattered, rounded punctation (dense, hexagonal in *emarginatus*) and median longitudinal line on pronotum absent (present in *emarginatus*). These characters collectively impart it the status of species novum.

Etymology: Species name pertains to truncate anterior margin of scutellum.

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FIVE NEW SPECIES OF THE GENUS *MACROCHELES* LATREILLE (ACARINA: MACROCHELIDAE) FROM EASTERN INDIA[1]

R.K. Roy[2]

(*With twenty-nine text-figures*)

Five new species of the genus *Macrocheles* Latreille are described from eastern India, namely *assamensis, punctosternalis, sikkimensis, bengalensis* and *crenulatus*.

Introduction

This paper describes five new species from eastern India. In an earlier paper (1988) I described *Macrocheles kamengensis* based on material collected from Arunachal Pradesh and Meghalaya. Of the five species dealt with in the present paper, two are from Assam (*M. assamensis* and *M. punctosternalis*), the third is from Sikkim (*M. sikkimensis*), the fourth is from West Bengal (*M. bengalensis*) and the remaining one occurs in Assam and West Bengal (*M. crenulatus*). Thus the number of species from the region, new to science under the genus, totals six to date.

The chaetotactic terminology used here is that of Lindquist and Evans (1965) for the dorsal setae and that of Evans (1963) for the leg setae.

Types have been deposited in the Zoological Survey of India, Calcutta. Measurements given in the text are in micrometres.

Macrocheles assamensis sp. nov.

FEMALE (Figs. 1-5): Dorsal shield (Fig. 1), 525 long, 300 wide, finely granular, with faint reticulations confined anteriorly and provided with 28 pairs of simple setae. Verticals, (j1), short, their insertions separated.

Sternal shield (Fig. 2) finely granulated, *l. ang.* conspicuous; *l.a.t.* short, not reaching bases of sternals I; *l.o.p.* short; sternal setae simple. Metasternal shields oblong, each with a pore at anterior edge and a smooth seta posteriorly. Genital shield broad, truncated posteriorly. genital setae simple. Ventri-anal shield (Fig. 2) 165 long, 120 wide, finely granular, ornamented with faint transverse lines between preanals I and III, preanals simple, adanals and postanal also simple. Metapodal shields represented only by weak sclerites laterad of ventri-anal shield. Stigmata laterally between coxae III-IV, peritremes extending anterodorsally beyond insertions of z1.

Gnathosoma with six rows of deutosternal denticles. Tectum (Fig. 3) tripartite, with central element forked distally; lateral elements fused; tectal base spinose. Movable digit of chelicera (Fig. 4) with a stout bicuspid tooth and one small tooth apically; fixed digit with a large backwardly directed tooth and a small tooth at apex; dorsal cheliceral seta simple; cheliceral brush less than half the length of movable digit.

Approximate lengths of legs (excluding pretarsi): I-405; II-315; III-285; IV-420; Tarsus I (90) longer than tibia I (75). Tarsus II (90) as in Fig. 5; tibia II (60). Genu IV with six simple setae.

MALE: Unknown.

Material examined: *Holotype* FEMALE, INDIA: Assam: Dibrugarh, Dibrugarh University Campus, Rajabheta, 10. vii. 1976, ex *Scarabaeus* sp., R.K. Roy coll.; *Paratype*: 1 female, data same as for holotype.

Distribution: INDIA: Assam.

Remarks: This new species shows resemblance to *M. neovernalis*, a beetle-associated species, described from the western Trans-

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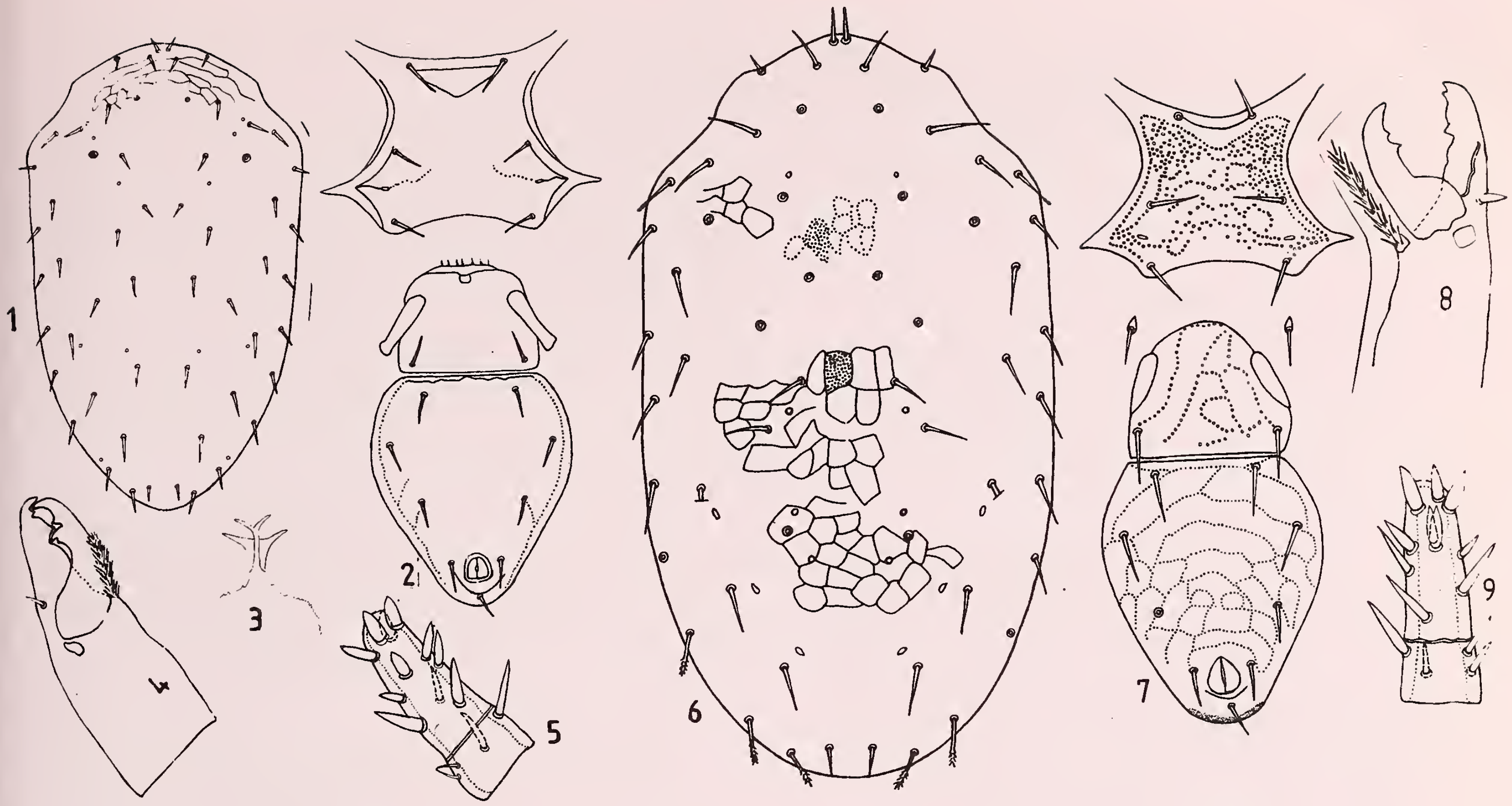


Figs. 1-5: *Macrocheles assamensis* sp. nov. Female: Fig. 1. Dorsal shield; Fig. 2. Venter; Fig. 3. Tectum; Fig. 4. Chelicera; Fig. 5. Tarsus II.
Figs. 6-9: *Macrocheles punctosternalis* sp. nov. Female: Fig. 6. Dorsal shield; Fig. 7. Venter; Fig. 8. Chelicera; Fig. 9. Tarsus II.

vaal by Ryke and Meyer (1958). But *neovernalis* possesses the following differentiating characteristics: verticals, (j1), plumose distally, J5 slightly pectinate; sternal shield with distinct *l.m.t.*; larger in size (650 in length, 363 in width).

Macrocheles punctosternalis sp. nov.

FEMALE (Figs. 6-9): Dorsal shield (Fig. 6), 606 long, 349 wide, punctate-reticulate and provided with 28 pairs of setae. Setae S4, S5, and Z5 plumose distally, r2 slightly pectinate distally, remainder simple and sharply pointed. Extra marginal setae simple.

Sternal shield (Fig. 7) granular with punctate ornamentation. Except *l.m.t., l. arc.* and *l.o.a.* other *liniae* not discernible, sternal setae simple. Metasternal shields small and each with a simple seta. Genital sheild granular and with punctate ornamentation. Ventrianal shield (Fig. 7), 197 long, 182 wide, granular and with transverse punctate lines. Metapodal shields elongate and poorly sclerotized. Peritremes looped laterally adjacent to stigmata and continuing anterodorsally beyond setae z1.

Gnathosoma with five rows of deutosternal denticles. Tectum not examined. Chelicera (Fig. 8) with both fixed and movable digit bidentate; cheliceral brush more than half the length of movable digit.

Approximate lengths of legs (excluding pretarsi): I-450; II-345; III-270; IV-420. Tarsus I (90) longer than tibia I (70). Tarsus II (90) as in Fig. 9; tibia II (60). Genu IV with six simple setae.

MALE: Unknown.

Material examined: *Holotype*: FEMALE, INDIA: Assam: Nowgong District, Lumding, 28. xii. 1973, ex nest material of *Passer domesticus* (L.), R.K. Roy coll.

Distribution: INDIA: Assam.

Remarks: This species resembles *Macro-*

cheles bacchusi Evans and Hyatt only in the punctate ornamentation of the sternal shield, but differs in possessing distinct *l.o.a.* Other differences are in the shape of genital, ventrianal shield, dorsal chaetotaxy and cheliceral dentition.

Macrocheles sikkimensis sp. nov.

FEMALE (Figs. 10-14): Dorsal shield (Fig. 10), 480 long, 255 wide, granular, weakly reticulate and bearing 28 pairs of simple setae. Insertions of verticals, (j1), contiguous.

Sternal shield (Fig. 11) elongate and with punctate ornamentation. *l.m.t.* undulating, *l. arc.* and *l. ang.* well-defined; sternal setae moderately long and simple. Metasternal setae simple, subequal to sternals III, each inserted on a small shield. Genital shield ornamented with punctate lines, genital setae simple. Ventrianal shield (Fig. 11) 150 long, 135 wide, rounded, somewhat truncated anteriorly and with three pairs of simple preanal setae, adanals also simple, postanal lost. Metapodals represented by a pair of small weak sclerites. Stigmata and peritremes as usual for genus; each peritreme continues anterodorsally nearly to insertion of z1.

Ventral groove of gnathosoma with five rows of deutosternal denticles, first groove without teeth. Tectum (Fig. 12) tripartite, central element distally divided; lateral elements fused, tectal base spinose. Movable digit of chelicera (fig. 13) with a large median bicuspid tooth and a smaller subterminal tooth; fixed digit with a subterminal tooth and with a broad median cusp; cheliceral brush short, less than half the length of digit.

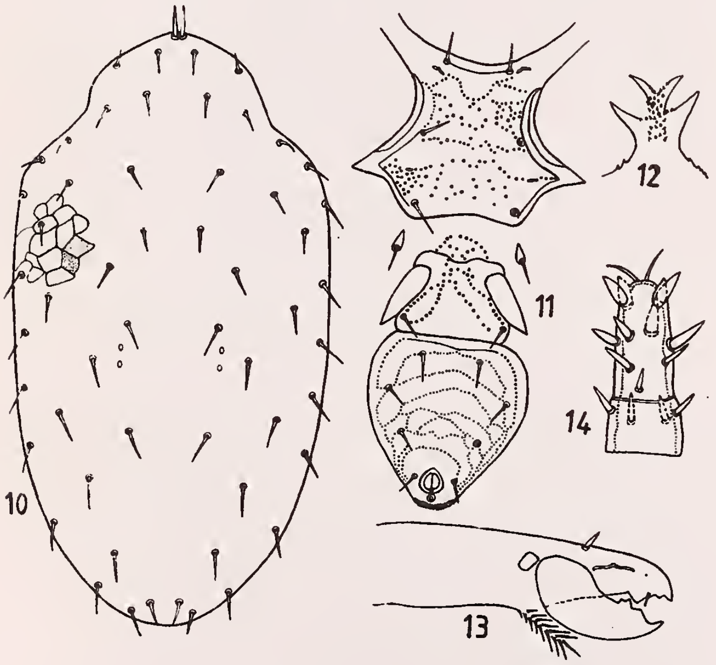
Approximate lengths of the legs (excluding pretarsi): I-375; II-300; III-240; IV-315. Tarsus I (75) longer than tibia I (60). Tarsus II (Fig. 14) 75, tibia II 60. Genu IV with six simple setae.

MALE: Unknown.

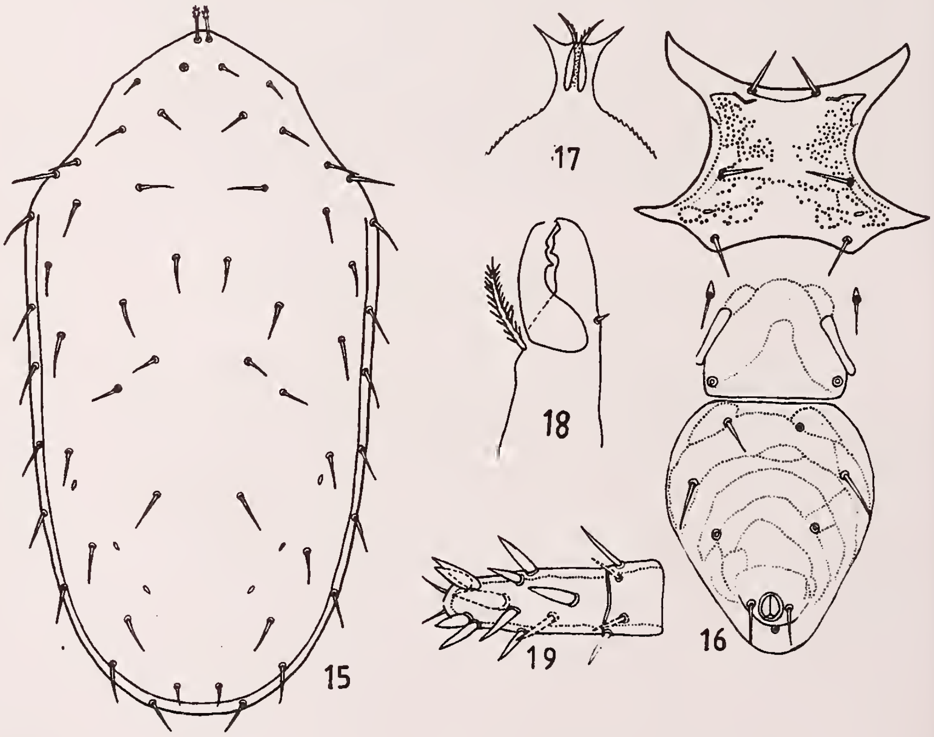
Material examined: *Holotype*: FEMALE, INDIA: Sikkim: Gangtok, 10.xi. 1977, ex *Scarabaeus erichsoni* (Har.), R.K. Roy coll.

Distribution: INDIA: Assam and Sikkim.

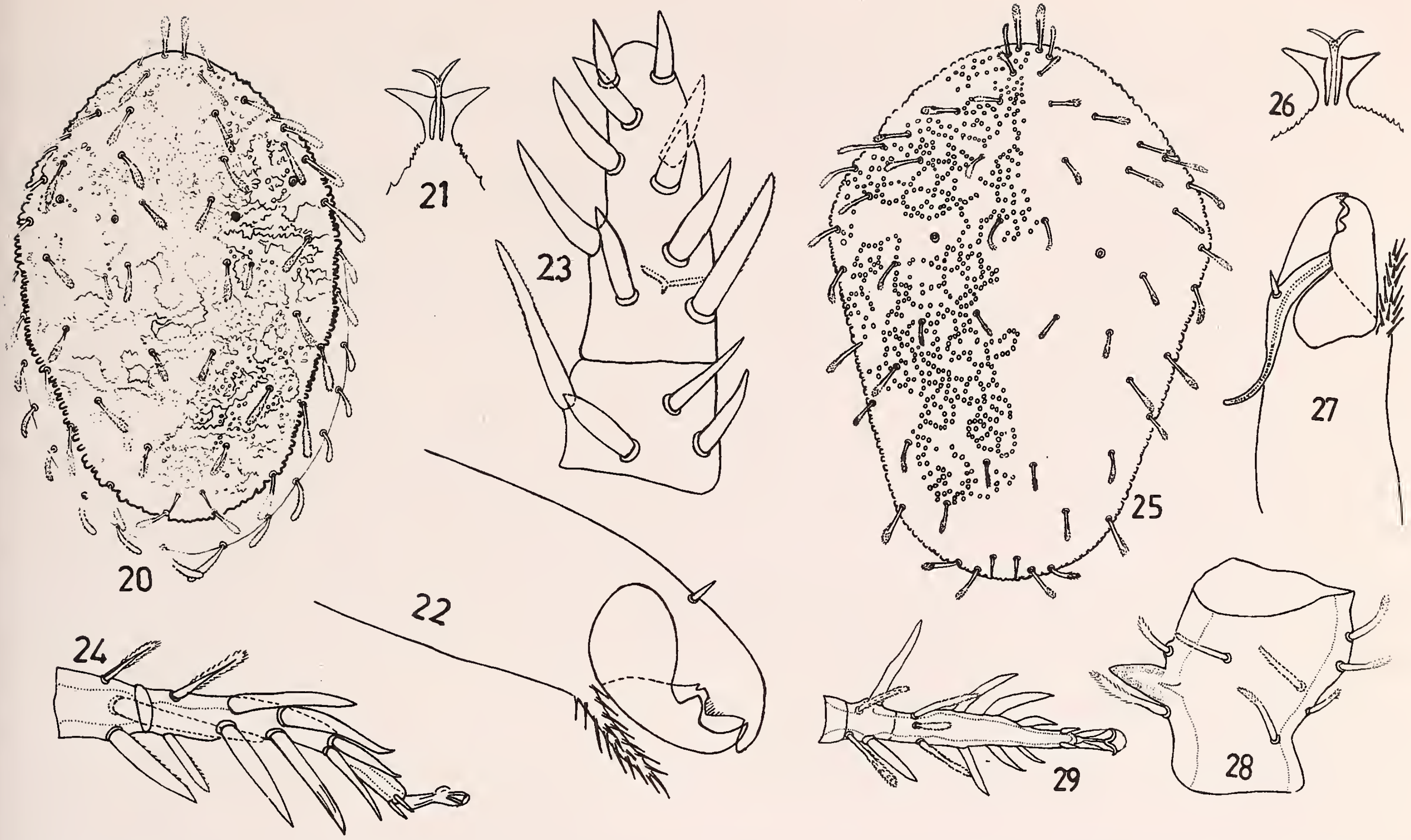
Remarks: Bhattacharyya (1971) misidentified this species as *Macrocheles merdarius* (Berlese,



Figs. 10-14: *Macrocheles sikkimensis* sp. nov. Female: Fig. 10. Dorsal shield; Fig. 11. Venter; Fig. 12. Tectum; Fig. 13. Chelicera; Fig. 14. Tarsus II.



Figs. 15-19: *Macrocheles bengalensis* sp. nov. Female: Fig. 15. Dorsal shield; Fig. 16. Venter; Fig. 17. Tectum; Fig. 18. Chelicera; Fig. 19. Tarsus II.



Figs. 20-24: *Macrocheles crenulatus* sp. nov. Female: Fig. 20. Dorsal shield; Fig. 21. Tectum; Fig. 22. Chelicera; Fig. 23. Tarsus II; Fig. 24. Tarsus IV.
Figs. 25-29: *Macrocheles crenulatus* sp. nov. Male: Fig. 25. Dorsal shield; Fig. 26. Tectum; Fig. 27. Chelicera; Fig. 28. Femur II; Fig. 29. Tarsus IV.

1889) and redescribed it. I collected it from soil under grass, at Moera Tetli, Tezpur, Assam. The present material has been collected from Sikkim.

Macrocheles bengalensis sp. nov.

FEMALE (Figs. 15-19): Dorsal shield (Fig. 15) 636 long, 303 wide, faintly reticulate and bearing 28 pairs of setae. Verticals, (j1), plumose distally, remainder simple.

Sternal shield (Fig. 16) as broad as long, ornamented with punctures; *l.m.t.* well-defined, *l.o.p.* punctate and extending medially. Metasternal shields triangular and each with a simple seta. Genital shield truncate posteriorly and ornamented with punctate lines. Ventrianal shield (Fig. 16) 182 long, 182 wide, as long as broad and ornamented with seven punctate transverse lines, ventrianal setae simple. Ventral integument striate and with simple setae. Metapodal shields elongate and weakly sclerotized. Peritrematal shield fused with dorsal shield for most of its length, peritremes extending anterodorsally to setae z1.

Gnathosoma with five rows of deutosternal denticles; external posterior rostrals one third the length of internal posterior rostrals. Tectum as in Fig. 17. Movable as well as fixed digit of chelicera (Fig. 18) bidentate, dorsal seta thickened; cheliceral brush more than half the length of movable digit.

Approximate lengths of legs (excluding pretarsi): I-424; II-348; III-258; IV-455. Tarsus I (106) slightly longer than tibia I (75). Tarsus II (Fig. 19) 90; tibia II 60. Genu IV with six simple setae.

MALE: Unknown.

Material examined: *Holotype*: FEMALE, INDIA: West Bengal: 24 Parganas (South), Narendrapur, 24. xii. 1979, ex poultry bed litter, B.N. Putatunda coll.

Distribution: INDIA: West Bengal.

Remarks: This species differs from all other species by the distinctive features of the sternal shield.

Macrocheles crenulatus sp. nov.

FEMALE (Figs. 20-24): Dorsal shield (Fig. 20) ornamented with scutellae, 788-848 long, 455-500 wide, heavily sclerotized and bearing 28 pairs of setae of varying length. Margin crenulate, attenuated posteriorly. Verticals, (j1), plumose, their insertions separated widely, setae J5 simple, pointed and remainder plumose.

Sternal shield as long as broad, strongly ornamented; sternal setae plumose. Metasternal shields ovoid and each with a plumose seta. Ventrianal shield 181-242 long, 181-288 wide, oval and reticulate; ventrianal setae plumose including adanals and postanal. Metapodals elongate lateral to preanals II.

Gnathosoma with six rows of deutosternal denticles. Tectum as shown in Fig. 21. Movable digit of chelicera (Fig. 22) unidentate; fixed digit bidentate; cheliceral brush more than half the length of movable digit.

Approximate lengths of legs (excluding pretarsi): I-530; II-485: III-500; IV-727. Tarsus I (121) longer than tibia I (90). Tarsus II (Fig. 23) 90 with stout setae, tibia II 60. Tarsus IV long and with dagger like setae as illustrated in Fig. 24. Genu IV with six plumose setae.

MALE (Figs. 25-29): Dorsal shield (Fig. 25) 424-428 long, 151-154 wide, ornamentation and chaetotaxy as in female.

Genital orifice presternal in position. Holoventral shield 424-426 long, 151-152 wide, ornamentation similar to dorsal shield, and bearing 19 plumose setae. Tectum as shown in Fig. 26. Fixed digit of chelicera (Fig. 27) unidentate; movable digit also unidentate; spermatophoral process long, cheliceral brush more than half the length of movable digit.

Legs sclerotized as in female. Femur II (Fig. 28) with a thumb-like spur; leg IV without any spur or protuberance; tarsus IV with thickened long setae as in Fig. 29.

Material examined: *Holotype*: FEMALE, INDIA: West Bengal: Darjeeling, Botanical Garden, 14. xi. 1973, ex leaf litter; *Allotype*: MALE, Assam: Karbi Anglong District, Diphu, along Diphu Lumding Road, 25. xii. 1973, ex forest leaf litter; *Paratypes*: 2 females, Assam: Nowgong District, Lumding, Jholanphul, 30. xii. 1973, ex decaying grass heap; 2 females, Assam: Majuli (Brahmaputra River Island), 16. vi. 1976, ex decaying wood log, J. Sharma coll.; 2 females, Assam: Dibrugarh District, Ledu, 14. vi. 1976, leaf litter mixed with dung, J. Sharma coll.; 1 male, Assam: Majuli, 16. vi. 1976, ex leaf litter, J. Sharma coll.

Distribution: INDIA: Assam, West Bengal.

Remarks: *M. crenulatus* approaches *M. kolpakovae* Bregetova and Koroleva in the ornamentation of ventral shields; shape of the ventrianal shield and in dorsal chaetotaxy, but the former can be separated from the latter in possessing plumose z2 (simple in *kolpakovae*); J5 simple (plumose in the latter); sternals II-III plumose (simple ri *kolpakovae*). Moreover both the species differ in cheliceral dentition: fixed digit bidentate in *crenulatus*, quadridentate in *kolpakovae* (vide Fig. 59, page 103, Bregetova and Koroleva, 1960; movable digit unidentate in present species. bidentate in *kolpakovae;* cheliceral dorsal seta is dentate in *kolpakovae,* simple in *crenulatus.*

ACKNOWLEDGEMENTS

I am indebted to Dr. S.K. Gupta, Zoological Survey of India, Calcutta, for providing unexamined material available in the Acarology Section, collected by B.N. Putatunda, leading to the discovery of one of the new species (*M. bengalensis*).

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OBITUARY

C. V. KULKARNI

(1911-1995)

(*With a plate*)

Dr. Chandrakant Vinayak Kulkarni, a former vice-president and Hon. treasurer of the Bombay Natural History Society, died on 28th December, 1995.

Born at Borli Panchatan (Kolaba District) on 11th August, 1911, CVK had his schooling at Bordi and joined the Wilson Collge, Bombay, where he obtained the B.A. (the Science) degree in 1934, with botany and zoology as subjects. He did his B.Sc. with zoology in 1935, and registered for M.Sc. by research at this college which degree he obtained after five years. It was during his postgraduate efforts that he discovered a new genus (and species) of fish, named *Horaichthys setnai* after the two stalwarts in Indian fisheries, Dr. S.L. Hora and Dr. S.B. Setna.

Meanwhile, after a short stint as a demonstrator in the Wilson College, CVK joined the Fisheries Section of the Department of Industries in the erstwhile Bombay Presidency as a Piscicultural Assistant. The Section was headed by a dynamic leader, Dr. S.B. Setna, who soon developed it to such an extent that the Government established a separate Department of Fisheries in 1945. This proved beneficial to CVK who got promoted as Superintendent of Fisheries. By this time, he had obtained his Ph.D. degree in 1943, the subject of his studies being the osteology of some Indian cyprinodonts. After the heady success of having discovered a new fish for his postgraduation, his Ph.D. work was a sort of climbdown, as it was more in the nature of routine, time-taking dissection requiring a great deal of patience but not much imagination. But CVK took it in his stride and got a reward for his efforts by winning his degree in three years.

In 1948-49, while an Assistant Director of Fisheries, he was deputed to U.S.A. by Government of India for a course in fisheries science at Washington.

It was in September, 1951 that I first met CVK. The Taraporevala Aquarium with its own Marine Biological Station had opened in May and I was fortunate to be its first student. CVK was to be my guide and, with his typical humility and matter-of-fact manner, he told me that he was a "fish" man and, therefore, I should not expect any technical guidance from him. (I had been given the study of taxonomy of marine and freshwater crabs of Bombay State and larval studies of crabs.) He used to come, dressed in a suit and necktie and a felt hat—a heritage of his U.S. visit.

It is said that some persons are born great, some achieve greatness, while greatness is thrust upon others. Dr. Kulkarni came in the last category as, with the retirement of Dr. Setna in 1954, as per seniority, CVK stepped into the shoes of Directorship. And then started his ordeal. It is unfortunate that CVK is often compared with his predecessor and considered not to be up to the latter's capability. Dr. Setna was a dynamic man, taking quick decisions and inspiring his team by personal example of the dignity of labour. CVK was more of a plodder—a man finely tuned to slow, painstaking research who would ruminate patiently for days before pinning down a ticklish scientific problem. I well remember how, as a newly married husband, he used to spend his Sundays (the only leisure day of the week, as Saturdays were half working days) walking all the way from Andheri railway station to Powai Lake (city buses did not ply there), and wading waist-deep to observe his favourite Bengal carps, which he had introduced there a few years ago.

His task as Director was made all the more laborious as the Secretary at Mantralaya was a stern taskmaster. His mode of working defied all modern management practice; even a peon's casual leave application had to go to him for approval. The outcome was that CVK took home two piles of files—each the size of a washerman's weekly laundry—every day. He was literally burning midnight oil to clear the backlog. Moreover, he liked to keep his own finger on the administrative pulse.

Dr. C.V. Kulkarni
(1911-1995)

As Curator of the Taraporevala Aquarium, if I shifted fishes from one tank to another, there would be a painful expression on his face, along with an admonishment, "But you did not even tell me before you did this." I also remember, when I was an Assistant Director in the sixties, that the head of a central government organisation was to send his departmental car to the airport to receive a foreign scientist. CVK asked me to telephone that Head at 6 a.m. to remind him. When I did so, the Head blew his top. It transpired that CVK had also asked our Deputy Director to remind the Head telephonically, and, not satisfied with that, CVK himself telephoned the Head so as to be on the safe side. I can imagine a person being disturbed three times in as many minutes as if he was irresponsible. People who did not know CVK well enough attributed such behaviour to lack of trust in his subordinates, but we who read him thoroughly took it in our stride, to be tolerated as one of his weaknesses.

But, with his patience and true zeal as a workaholic, he finally overcame his foibles and, with the passing of time, even achieved the status of a father-figure in Indian fisheries. He was helped greatly by political developments. Bombay State was a long, narrow stretch of land with a long coastline. His predecessor, Dr. Setna had won laurels for his grand success in the mechanisation of indigenous fishing boats. With the reorganisation of States in 1956, a vast chunk of land from the erstwhile Central Provinces (Madhya Bharat) and the Nizam's Hyderabad State were added as Vidarbha and Marathwada. The scheme of mechanisation of fishing boats had lost its momentum, but aquaculture in freshwater lakes and ponds got a fillip. Research was CVK's *forte*, and he soon won acclaim for taking this up on a large scale in our State.

Dr. Kulkarni retired as Director of Fisheries in 1970, and with his retirement ended the glorious era of the State Fisheries Department as a balanced mix of high class research and administration, which could hold its head high and be favourably compared with reputed departments such as of erstwhile Madras and Travancore-Cochin. But CVK continued to keep in close touch with fisheries, being on several committees dealing with fishery research, education, management, quality control and export promotion. He was the founder President of the Indian Fisheries Association and a President of the Bombay Aquarium Society for a few years.

After retirement, his service were sought by the Tata Electric Companies for establishing a centre at Lonavla for breeding mahseer-an anglers' delight for which tourists come from all over the world, and whose populations have declined all over the country. With his meticulous planning and able assistance from scientists on the spot, this scheme has become a grand success.

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B.F. CHHAPGAR

REVIEWS

1. A NATURALIST IN KARBI ANGLONG. By Anwaruddin Choudhury. pp. 78 (21.5 x 14 cm), with illustrations. Guwahati, 1993. Gibbon Books, Islampur Road, Guwahati 781 007. Hardbound Rs. 275, £ 8, $ 15. Paper back Rs. 150, £ 5, $ 10.

Knowing little about Karbi Anglong, I was fascinated by the obvious wealth of flora and fauna evident in the various districts to which the author travelled in his year's sojourn.

His obvious desire to save his knowledge of the environmental problems engendered by the tribes.

His research into the local unique flora and fauna was meticulous and the more I read of the book the more enticing the area because I was particularly interested by his reference to the Yeti in Chapter Six, where he describes sightings by several reliable sources of a large ape-like primate running bipedally and covered in dense black fur which has been sighted occasionally in various reserve forests in the region. This is the first reference I have been to a Yeti (Kheulong-po as called by locals) in this area and backs up numerous other sightings by the people of the western Himalayas.

His suggestion that ecotourism be encouraged might if carefully monitored, benefit the region. However, with the limited forest support systems I wonder if implementation of any rules or laws could be enforced.

My one criticism, if justified, is his use of the English language which in places left a great deal to the desired. Overall, this little book which appears to be a one man effort should be recommended to any naturalist interested in exploring further into the less frequented areas of this country.

PHILIPPA MUKHERJEE

2. ORNITHOBOTANY OF INDIAN WEAVER BIRDS. By Satish Kumar Sharma. pp. 235 (21.5 x 14 cm), with many coloured and Black & White illustrations. Udaipur & Delhi, 1995, Himanshu Publications. Price Rs. 425.00.

The title of this book is a word coined by the author to describe that part of nature study where ornithology and botany overlap. The present volume is a study of weaver birds which does not concern itself with its breeding biology or field habits; it concerns itself solely with the kind of vegetable material it needs and uses mainly for nest building. His studies were carried out in Rajasthan around the three local species of the Indian Baya (*Ploceus philippinus*), the striated weaver bird (*P. manyar*) and the black-throated weaver bird (*P. benghalensis*).

Although Dr. Sharma's study is based mainly on his own personal observations and experiments, he makes use of the Old Masters to support and reinforce his conclusions at every point. His list of "Cited References" runs into 9 pages. His indices and Glossary are complete and accurate. Dr. Sharma's work is meticulous and obviously reliable.

We all have a mental picture of the typical group of baya nests dangling from some palm tree in the middle of a field. Dr. Sharma spells out the places you would *not* find a baya colony — for instance, you would not find it in a thick forest, nor in a tree with a heavy or large canopy, nor in a palm with only upright leaves. The leaves must be green and supple; although dead trees can be used if they are surrounded by water which gives protection against terrestrial predators. The next step is choosing the right material for nest building — and sketches are provided to show the exact manner in which strips of green material is chosen, collected, and carried to the nest site; after that comes the plastering (with mud and dung) and then waiting for the approval of a female before the nest is completed. The many half-finished nests are proof of the failure of a cock to win a mate.

Dr. Sharma uses innumerable sketches, diagrams, tables and graphs to describe every aspect of the baya's nest building activity. One chapter is devoted to Nest Beautification. It is well-known that bayas will often weave a flower into their nest — one assumes that this is just for "looks". The author describes this phenomenon minutely — again with the help of diagrams and tables, and comes to the conclusion that the most favoured colour for "beautification" is yellow. The last chapter deals with "abnormal" nests. Obviously, in any nest as intricate as the bayas choose to make, there will be a margin for mistakes and abnormality. Again, all such abnormalities are carefully listed and documented in words and pictures.

It might seem to amateurs, that the detailed and accuracy in describing some of the things which we tend to accept as obvious and everyday may not always be necessary. And yet the true scientist is one who will refuse to take anything for granted, no matter how familiar. In that sense Dr. Sharma is a true scientist. Sálim Ali was the first to study the Indian baya "in depth". Dr. Sharma has used his work, and the work of many subsequent naturalists to give us a rounded, scientific and complete picture of the Indian baya and its nest.

ZAFAR FUTEHALLY

MISCELLANEOUS NOTES

1. MEAT EATING BY LION-TAILED MACAQUE, *MACACA SILENUS* (ZIMMERMANN)

For the past one year we have been conducting studies on the impact of habitat fragmentation on small mammals in the wet evergreen or rainforests in the Indira Gandhi Wildlife Sanctuary (previously Anamalai Wildlife Sanctuary) in Tamil Nadu. The study funded by the Ministry of Environment and Forests, Govt. of India, focuses on arboreal mammals, terrestrial rodents and small carnivores.

On 27th December 1994 we were busy doing group scan of our study troop of Lion-tailed macaque (LTM) in a rain forest fragment at Varattuparai in the Indira Gandhi Wildlife Sanctuary near Valparai. At 1545 hrs we heard the alarm calls of a giant squirrel about 75 m to our right. We found that the calls came from a *Mesua ferrea* tree where an adult male LTM was actively taking apart a giant squirrel nest, while two squirrels were giving alarm calls in order to keep the monkey away. The male LTM picked out a young giant squirrel (probably a sub-adult) by its throat. Soon the LTM leapt to a *Cullenia excelsa* tree with the squirrel in its mouth and sat in the top peripheral canopy. The other monkeys of the group were feeding on *Cullenia* fruits on the same tree. The male started eating the giant squirrel, peeling its skin from the head. It finished eating the squirrel in 30 minutes, leaving only the claws, paws, skull and skin. The skin measured 60 cm from head to tail, with a tail of 35 cm. While feeding on its prey, the male never allowed any other individuals to come near. Feeding on mammalian prey has been reported in baboons and chimpanzees. In the LTM, feeding on giant squirrel infants has been reported before in the Anamalais (Kumar 1987). What makes this observation striking is the size of the prey, which was a sub-adult or juvenile. In addition to this we have also observed LTM feeding on flying squirrels in Puthutotum estate near Valparai. Studies in undisturbed forests have shown that LTM gets protein mostly from animal matter, especially foliage insects, and rarely mammalian prey. It is likely that predation on mammalian prey might increase in highly degraded forests such as privately held estates and forest fragments, because the availability of foliage insects might be considerably less compared to undisturbed forests.

March 13, 1995

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2. PANTHER, *PANTHERA PARDUS* (LINNAEUS) WITH GUINEA WORM INFECTION

About 30 Km from Udaipur there is a place called Dholi Ghati situated in a valley. In the early fifties this area was inaccessible by road and sparsely populated. Near Dholi Ghati there were three villages Jogion-Ka-Guda, Sahawaton-Ka-Guda and Majam. The whole area teemed with game and was a favourite hunting ground of my father.

In those days the chief ailment of the people of this region was, Guinea Worms, Dysentry and Malaria. My father during his jungle excursions always carried a first aid kit to treat the people suffering from these aliments. To treat Guinea Worm patients he used a simple method. When a Guinea Worm protruded partly from a blister he would inject a minute quantity of Tincture Iodine into the Worm with a very fine hypodermic needle and would tie the worm. Within 24 hours the iodine would kill the worm thereby loosening its grip on the muscles of the patient. Later it can be wound on a stick slowly and extracted from the patient.

My father the late Shri T.H. Tehsin's diary shows that during the winter of, 1948 he had treated 900 patients suffering from Guinea Worm at Dholi Ghati during his stay of 2 months. One of the parient's had 80 Guinea Worms in his body. One even protruded from his tongue. He expired within a fortnight. This proves the gravity of the suffering of the people from this disease in those days.

While looking through the diaries I came cross an interesting note. On 6th February 1952 my father shot a leopard in Kachot, a place near Dholi Ghati, in a beat. The animal was very lean. While skinning, he found some yellowish fluid oozing out from a small wound, just above the right eye of the animal. He cut the flesh near the wound and extracted a thin, long, white worm, which he noted was a Guinea Worm. Leopards too apparently suffered from Guinea Worm infection.

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3. SOME NOTES ON HIMALAYAN PALM CIVET, *PAGUMA LARVATA* (HAMILTON-SMITH) (CARNIVORA: VIVERRIDAE)

The Himalayan Palm Civet *Paguma larvata* is a tree civet found in the outer and greater Himalaya. Between 1989 and 1992 three dead specimens of the species were found by me in the university campus at Nauni and around Solan (30° 52' North latitude and 77° 11' East longitude) in Himachal Pradesh, at an altitude of 1300 m and 1500 m respectively. The forests around Solan are represented by subtropical pine forests. (Champion and Seth 1968). The dominant tree species is Chir Pine (*Pinus roxbughii*) followed by Ban Oak (*Quercus incana*) at higher altitudes. Shrubs are represented by *Rosa* sp., *Viburnum* sp. and *Debregeasia* sp. Two of the dead civets bore bullet marks on their body. The third one appeared to be a case of natural death. The present communication is based on the reports dealing with these dead specimens, interrogation reports of farmers in the study area and on observations made on a captive specimen.

According to Roberts (1977), this species is largely frugivorous and there are many instances of their raiding apricot, pear and apple trees when the fruit is ripening. A specimen of this species which was shot by a farmer at midnight in May 1989 near Solan was recovered by me.

The animal had been visiting a Loquat tree (*Eriobotrya japonica*) near the farmer's house for a week doing a lot of damage to ripening fruits. The faeces of the animal with Loquat seeds were also recovered by me close to the Loquat tree. Subsequently I visited several orchards mostly of stone fruits like peach (*Prunus persica*), plum (*Prunus domestica*), apricot (*Prunus armeniaca*) and vegetable fields around Solan and in the campus of Dr Y.S. Parmar University at Nauni. Almost all the farmers when questioned about this civet said that the animal is a serious pest of stone fruits like peach, plum, apricot and vegetables like peas and tomato. The farmers admitted that they do not hesitate to kill it. The civet is locally called 'Ooj' since it damages their orchards and vegetable crops. Their views were confirmed by the analysis of gut contents of another specimen which was shot and killed by someone near the university campus in May 1991. The analysis revealed that the animal had consumed green peas and apricots which are grown in plenty in the university campus and its surrounding areas. In December 1992, civets are reported to have dug up the seeds of apricot and peach stored in a pit for stratification in the university campus at Nauni. The endocarp of the seeds were removed by the animals before consuming the kernels.

Another civet was found dead by me near the Boy's Hostel of the University in 1992. The animal was also seen by the inmates of the hostel at noon a few days prior to its death. This confirms the findings of Roberts (1977) that the species is not exclusively nocturnal. The dead specimen was infested with ticks identified as *Boophilus microplus.*

A live specimen of this species is kept in captivity at Jawahar Park in Solan. The specimen would readily eat fruits like plum, pear, apple, peach, apricot, etc. It also relishes bananas eating the endocarp and mesocarp while the ectocarp is rejected. The animal likes tomatoes also but potatoes, pods of beans (*Phaseolus vulgaris*) and chilli fruits (*Capsicum annum*) were rejected. Only one pod of peas (*Pisum sativum*) was accepted out of three offered. Its routine diet includes bread, milk and bananas. The animal would approach the eatables thrown into the cage sniffing alone the ground. During the process the vibrissae are always kept backwards. The animal is active mostly during morning and evening hours and accepted food during this period only. During the day time, the animal was always found sleeping and did not wake up even when disturbed.

The flesh of the shot animals, as told by the villagers, is not thrown but always consumed by the villagers. But there were no reports suggesting that the animal is killed for its flesh only.

It can be concluded from the above account that Himalayan Palm Civet *Paguma larvata* (Hamilton-Smith) damages fruits and vegetables in the mid-hills of Himachal Pradesh.

ACKNOWLEDGEMENT

I am grateful to the Head, Department of Silviculture and Agroforestry, Y.S. Parmar University of Horticulture and Forestry, Solan, for facilities provided.

January 19, 1996.

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4. OCCURRENCE OF THE WOLF (*CANIS LUPUS* LINNAEUS) IN REWA DISTRICT (M.P.)

The present distributional status of the species includes six civil districts of the Madhya Pradesh State (S.P. Shahi, *JBNHS*, 79: 493-503, accompanying map showed known wolf habitats).

On 23 March 1993 while travelling from my H.Q. at Sidhi to Rewa, a solitary Wolf was sighted in Chhuhiyaghat section on Govindgarh side, around 1700 hr., crossing the road in front of our slow moving vehicle. This location was amidst hilly scrub forest. Incidentally, this degraded area is a part of the same forest, where the Ex-Ruler of Rewa State, captured a white tiger Cub.

Earlier in the year 1978, a wolf was seen in the scrub bush forest between Kanker and Keshkal in the Bastar Dist. of Madhya Pradesh.

These locations are additions to the known distribution of the species.

February 22, 1995

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5. A RECORD OF THE NILGIRI MARTEN (*MARTES GWATKINSI* HORSFIELD) IN UPPER BHAVANI

The Nilgiri Marten (*Martes gwatkinsi*) was sighted in Upper Bhavani on 22nd January 1995 at 0700 hr, while walking towards Bison swamp for our field work. A sambar (*Cervus unicolor*) was disturbed by our presence and started running through the swamp after giving its alarm call. Immediately a Nilgiri Marten came from behind a hidden boulder and stood on its hindlegs and looked around. It stood about 15 m ahead of us. We were able to see it clearly with naked eye and through binoculars. It was about less than a meter from head to rump, dark brown in colour with buff white on its throat and had a black stripe on its snout. As we were puzzled, we could not make certain whether the throat was dusty white or yellow. After a few minutes it disappeared into the shola. The swampy area was surrounded by different sized shola patches and wattle plantations. The altitude of the area was above 2000 msl. All the above details coincide with the descriptions given in Prater (1971, The Book of Indian Animals). This is the first record from Upper Bhavani.

February 15, 1995

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6. BACK RIDING AND POSSIBLE AERIAL MATING AMONGST THE LARGE FRUIT BAT, *PTEROPUS GIGANTEUS* (BRUNNICH)

A rather interesting phenomenon was observed by me on 10th September 1991around 1800 hr., while sitting outside the office campus at Beohari, Shahdol District of Madhya Pradesh.

Several Large Fruit Bats (*Pteropus giganteus*) were observed flying in our direction and flying over and behind us. Suddenly, one of two almost equal sized bats, which were flying parallel to each other, indulged in an unexpected act. It mounted the other bat, though for a few seconds only, then dismounted and continued its normal flight. The noticeable points were, that the impact of the mounting bat caused a dip in the flight of the other bat and the dismount was associated with jerks of the ventral portion of the mounted bat, which suggests, possible mating. Thereafter a keen eye was kept on other bats, but the act was not repeated.

The carriage of young on their backs has been recorded in other species of bats (Brosset *JBNHS* 59: 57). The method of mating has been described as the male overlapping female while hanging and the normal copulation posture is as that among mammals (Brosset *JBNHS* 60: 350).

February 22, 1995

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7. INTERBREEDING BETWEEN GRIZZLED GIANT SQUIRREL, *RATUFA MACROURA* (PENNANT) AND MALABAR GIANT SQUIRREL, *R. INDICA* (ERXLEBEN)

The endangered Grizzled Giant Squirrel (GGS) exists in a few isolated populations in Tamil Nadu, Kerala and southern Karnataka (Davidar 1989, Ramachandran 1989, Joshua 1992, Karthikeyan *et al.* 1992) and Sri Lanka (Wroughton 1910, Phillips 1915, Ellerman 1961). The Srivilliputtur Grizzled Giant Squirrel Wildlife Sanctuary (SGGSWS) in Tamil Nadu harbours the largest population of *c.*200 animals where it occurs in Ayyanarkoil, Viriyankoil, Alagarkoil, Pulavukal, Koilaar and Sunderamahalingamkoil areas which are isolated. Ayyanarkoil Valley which lies on the southeastern boundary of the sanctuary, is the southern most limit for the species.

GGS is sympatric with the Malabar Giant Squirrel (MGS) in the Ayyanarkoil Valley in Rajapalayam Hills in the SGGSWS (Joshua 1992). In the Palani Hills where both GGS and MGS are present, they occur at different elevations (Moore and Tate 1965, Agarwal and Chakraborty 1979).

During a survey for these squirrels in Ayyanarkoil Valley in January 1989, I saw a GGS female and a MGS male lying close, one behind the other on a branch of an *Albizia lebbeck* tree at 18 m from the ground. The time was 0815 hrs, which usually is the peak feeding time (Joshua 1992). At 0912 hr. The MGS male approached the GGS female where upon she turned and chased him. In GGS this chasing usually ends up in mounting and is a sequence in the mating behaviour. At 0928 hr., the MGS male successfully mounted the GGS female for a few seconds. After resting for about 20 min., the MGS male again started to go behind the GGS female. In the meanwhile a GGS male interfered and the MGS male started chasing the GGS male away from the female. For the rest of the day MGS male was involved in keeping the GGS male away during which he attempted to mount the female only twice, both unsuccessfully. At 1720 hr., the MGS male moved away from that area.

On the second day both the squirrels were not seen. As I continued my survey looking for squirrels, I was surprised to see a MGS with grey colour instead of the usual maroon around the belly and the flanks. It was most probably a hybrid between MGS and GGS. By the end of the survey I had seen nine *R. macroura,* 11 *R. indica* and seven hybrids. All the hybrids had coat colours of both MGS and GGS.

The most preferred habitat of GGS is the riverine habitat. In the past, in Ayyanarkoil Valley, a 6 km riverine patch, was destroyed and the GGS were pushed towards the foot hills where MGS exists. That is why they are sympatric in this area.

It is evident that mating of MGS and GGS is a common feature at Ayyanarkoil Valley as GGS are pushed into the MGS habitat due to habitat degradation. It would be interesting to see whether these hybrids are fertile. This could be a feature at Palani hills area where both species co-exist. These areas should be regularly monitored to see which species becomes locally extinct and whether the hybrid would survive or not. Monitoring is also necessary to see whether one of the two is likely to face extinction from the foothills due to competitive exclusion by the other species. It is noteworthy to recall such competitive exclusion of native red squirrel in southern and eastern England by the introduced grey squirrel (Lloyd 1983, Reynolds 1985).

July 4, 1995 JUSTUS JOSHUA

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8. UNUSUAL FEEDING BEHAVIOUR OF SQUIRREL, *FUNAMBULUS* SPP.

The BOOK OF INDIAN ANIMALS by S.H. Prater states that the usual food of Squirrels are fruits, nuts, young shoots, buds and barks. Insects are eaten at a pinch, as also the eggs of birds.

Some years ago when I was in school at Jaisalmer, Rajasthan (1976-77), a squirrel, perhaps the five-striped, was noticed feeding on a bird (House Sparrow). The bird was apparently sick and was standing quietly at the side of a wall on the roof in the summer around 3-4 p.m. The bird was perhaps, unable to fly. I was watching the bird at a distance of about 8 to 10 m. Suddenly a squirrel came down, looked around and reached the bird. It caught the bird which struggled a little, flapping its wings, but it could not fly and free itself from the squirrel and fell on the same spot. I kept on watching the behaviour of both. Within a few minutes the squirrel ate half of the hind part of the bird and went away, leaving the rest behind.

This unusual behaviour of the squirrel (*Funambulus* spp.) indicates that they are not only herbivorous but are also occasionally carnivorous.

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9. TOXICITY OF WAX BLOCKS AGAINST RODENTS IN LABORATORY AND FIELD CONDITIONS

INTRODUCTION

Wax block baits have lately drawn worldwide attention in field rodents control by its easy application, high acceptability, bait durability and easily accountable left over. High acceptability of cholecalciferol wax blocks against *Tatera indica* and *Rattus rattus* was reported by Mathur and Jain 1987, brodifacoum wax blocks against some Indian rodent species by Soni and Tripathi 1989, Bromadiolone and Warfarin cakes against house rat by Jhala *et al.* 1984. On the basis of these observations, attempts were made in the present investigation to evaluate comparative efficacy of rodenticide embedded in a mixture of cereals and paraffin wax cakes in the laboratory and field conditions.

MATERIAL AND METHODS

Laboratory no-choice feeding test was carried out to evaluate the toxicity of poisoned baits of fumarin 0.025%, warfarin 0.025%, Bromadiolone 0.005%, cholecalciferol 0.005% and flocoumafen 0.005% embeded in a mixture of cereals and paraffin wax against *M. hurrianae.* All the animals were sexed, weighed and acclimatized to laboratory conditions prior to the experiments. Rat feed (Hindustan Lever Ltd., Bombay) and water were provided *ad libitum.* The animals were weighed and starved for 24 h. Poison cake of 10 g each was exposed to individually caged animals. For each poison bait twenty animals of both the sexes were used. Cakes were exposed for 24 hr. Leftover and spilled food was also weighed and recorded. After 24 hr. of poison baiting fresh rat feed was provided daily until death.

In another set of experiment, the field was selected and the investigation was carried out in village Nyla, 24 km from Jaipur. The village has a compact block of wheat and barley crops. About 8 ha. of area was selected for each poison bait. The pretreatment level of infestation was estimated by adopting the burrow count method (Barnett and Prakash 1975). The burrows in the study area were sealed with wet soil and lime. The reopened burrows next day were taken as live burrows. The burrows of each field area were treated with wax cakes of 0.025% of fumarin, 0.025% of warfarin, 0.005% of Bromadiolone, 0.005% of brodifacoum, 0.005% of cholecalciferol and 0.005% of flocoumafen of 10 g each. After treatment the burrows were closed and marked.

On the second day the live burrows were counted and closed again for the next observation. Similarly on the third day, the live burrows were again counted and observations were recorded.

acceptability. The efficacy was judged by the live burrows. There was 90%, 86%, 88%, 80%, 78% and 75% control success observed with bromadiolone, cholecalciferol, brodifacoum, flocoumafen, fumarin and warfarin respectively.

Results evidently reveal that bromadiolone wax cakes were found to be more effective, 90 per cent mortality; followed by brodifacoum (88%), cholecalciferol (86%), flocoumafen (80%), fumarin (78%) and warfarin (75%).

TABLE 1

TOXICITY OF VARIOUS RODENTICIDE WAX BLOCKS AGAINST RODENTS IN LABORATORY CONDITION

Rodenticide wax block exposed for a day	Consumption of poison bait (g)	Ingestion of poison (mg/kg)	Mortality %	Days to death	
				Mean	Range
Fumarin (0.025%)	4.88	4.42	80	10	6-14
Warfarin (0.025%)	5.12	3.98	78	12	7-16
Bromadiolone (0.005%)	5.98	4.24	94	8	4-12
Brodifacoum (0.005%)	6.85	4.65	90	7.5	5-13
Cholecalciferol (0.005%)	5.62	4.52	88	7.8	6-15
Flocoumafen (0.005%)	7.15	3.77	82	8.2	6-13

RESULTS AND DISCUSSION

The results of one day no-choice test reveals 78 to 94% mortality in the laboratory which suggests that most of the poison could be used as single dose poison (Table 1). However, while comparing the efficacy of all the rodenticides the results indicate that bromadiolone and brodifacoum require low lethal dose with minimum days to death, i.e. 4-12 in case of bromadiolone and 5-13 with brodifacoum. The mean consumption of poisoned cakes of bromadiolone and brodifacoum was 4.24 and 4.65 mg/kg of body weight respectively. High efficacy of bromadiolone and brodifacoum wax cakes against *Rattus rattus* has been reported by Dwivedi *et al.* (1989). Mathur and Jain (1990) reported wax block formulation of bromadiolone (0.005%) as very effective and indicated 83.33% and 100% mortality when it was exposed for 2-3 days respectively.

Observations from the field studies (Table 2) indicate that poisoned cakes of bromadiolone, brodifacoum and cholecalciferol were consumed more by the rodents, which shows their higher

Bromadiolone has also been tried on other species of rodent in different habitats. It has been reported as effective in controlling *R. rattus* on crown of cocount palms, in houses, according to Shamsuddin and Abdulla koya (1983). Marsh *et al.* (1980) reported 87% control of Norway rats with single dose application of bromadiolone in an experimental field trial in West Indies. Toxicity test carried out to test the efficacy of bromadiolone in field and houses by Saxena and Singh (1987) reported maximum kill between 6-8th day of exposure of the poison. The findings are further supported by the study carried out by Chopra *et al.* (1982) who reported single exposure of poison bait (Bromadiolone 0.005%) resulting in 100% mortality of *Rattus meltada* and *Mus platythrix*, 60% mortality of *Bandicota bengalensis* and 85% kill of *Rattus rattus*. The higher degree of acceptability of bromadiolone wax cakes despite its toxicity to rodents reveals that it is potentially useful for wide

TABLE 2
TOXICITY OF VARIOUS RODENTICIDE WAX BLOCKS AGAINST RODENTS IN FIELD

Rodenticide wax cakes	Concentration (%)	Feeding in days	Live burrow count: Pretreatment	Live burrow count: Post treatment	Control Success percentage
Fumarin (Ratokilbar)	0.025	2	174	38	78
Warfarin (Rodafarn-R)	0.025	2	192	48	75
Bromadiolone	0.005	2	188	23	90
Brodifacoum	0.005	2	162	28	88
Cholecalciferol	0.005	2	178	25	86
Flocoumafen	0.005	2	176	35	80

range of rodents. The major rodent species present in this study area were *Meriones hurrianae, Rattus meltada* and *Tatera indica.*

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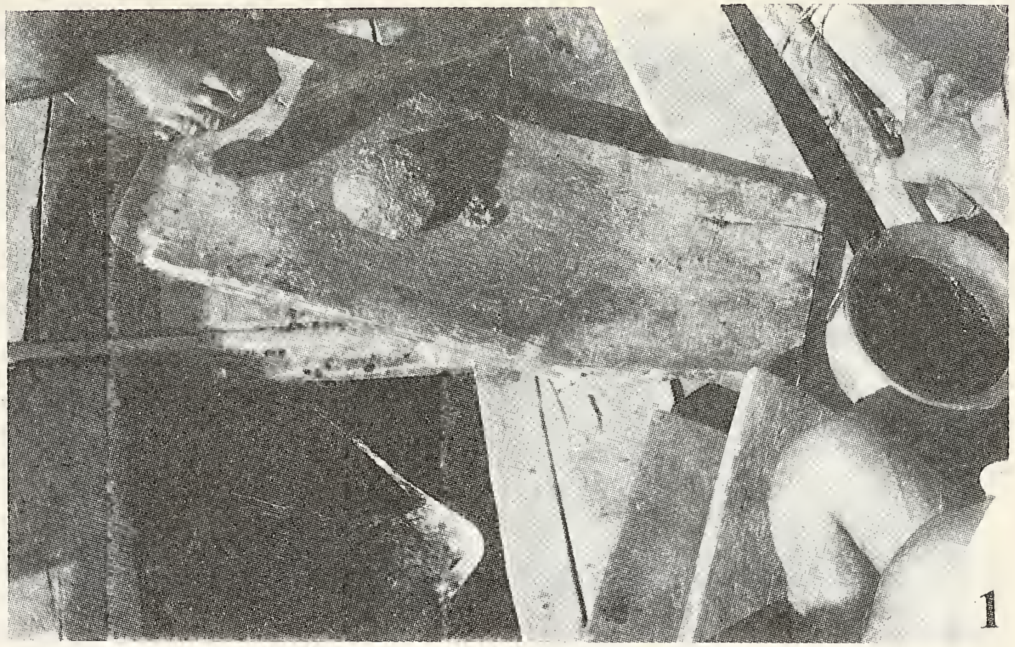
10. FISH OILS AS ALTERNATIVE TO RIVER DOLPHIN, *PLATANISTA GANGETICA* (LEBECK) OIL FOR FISHING CATFISH *CLUPISOMA GARUA* IN THE RIVER GANGES, INDIA

(*With a plate*)

INTRODUCTION

The River dolphin's (*Platanista gangetica*) oil is extensively used in the Ganges and Bramhaputra rivers in fishing operations for the freshwater catfish *Clupisoma garua* (Ham.) (Motwani and Srivastava 1961, *JBNHS* 58:285). It is estimated that oil is extracted from about 50 river dolphins caught annually between Patna and Rajmahal from the Ganges (pers. obs.). It was suggested that the poaching pressure on the river dolphin can be reduced if an alternative to dolphin oil can be found.



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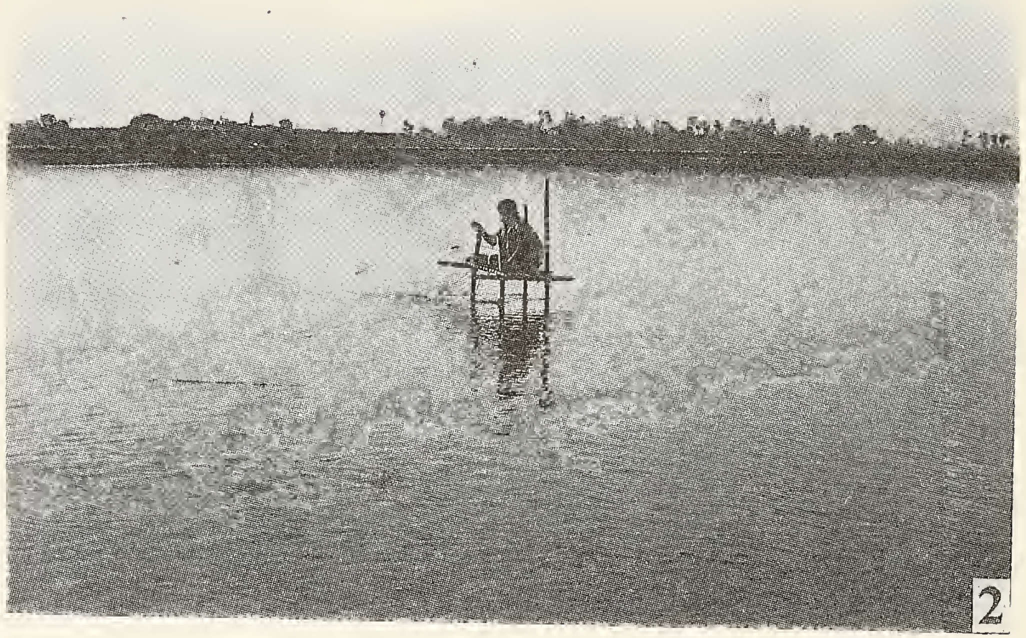

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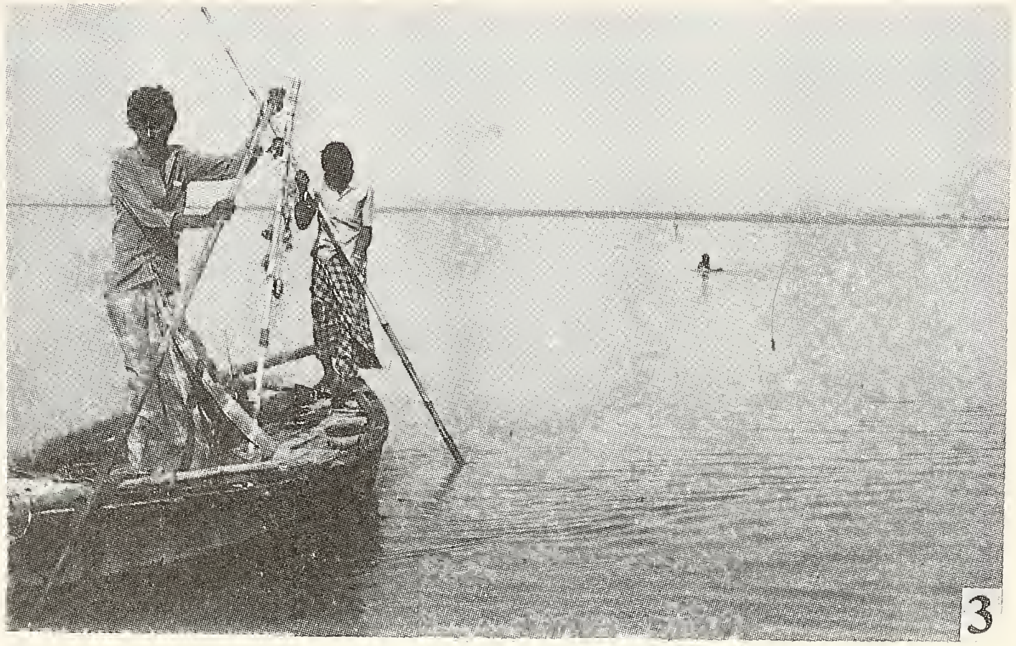

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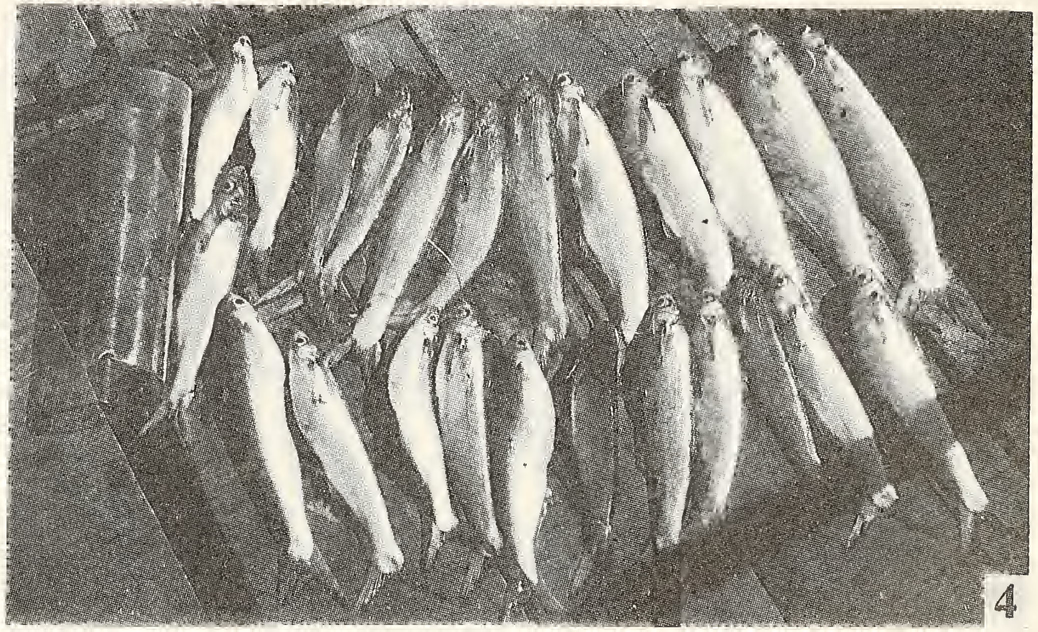

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Fig. 1. Dolphin oil bait (on the wooden plank) and the dolphin oil in the aluminium vessel. Preparation of the bait.
Fig. 2. Bait being sprinkled from a `Machan' in river Ganges. Fig. 3. Second phase of sprinkling of the bait.
Fig. 4. *Clupisoma garua* caught by using the dolphin oil bait in the river Ganges.

The method of using dolphin oil for luring the catfish is interesting. About 300 gm of dry cowdung is powdered and 40 ml of dolphin oil added to it and mixed well (Plate 1, Fig. 1). This mixture is taken in a vessel and sprinkled on the surface of the water by a fisherman seated on a specially made platform known as 'Machan' in the river where the water depth was about 1.5 m (Plate 1, Fig. 2). About two hours after completing the sprinkling of the 'lure' the fisherman moves about 2 km upstream. Another mixture prepared by mincing goat's fat, stomach and intestine with cowdung is made into a ball and a depression made in its centre. About 10 ml oil is poured into it. An experienced fisherman dissolves the 'lure' with a rhythmic action keeping the lure on one hand and pinching a portion and dissolving it with the other hand (Plate 1, Fig. 3). After about an hour when all the 'bait' has dissolved, a rectangular net is prepared to haul the fishes lured by the bait near to the fishermen.

Material and Methods

Easily available fish oils like crude shark liver oil with different acid values, sardine (*Sardinella longiceps*) oil and the Ganges river dolphin oils were used for the experiments. The experiments were conducted in the river Ganges near Bhagalpur in the small village of Colgone, Bihar. The oils were given to the fishermen and they were requested to carryout the fishing in the traditional way under the supervision of the authors and other field staff. The trials were conducted simultaneously at different centres. It is a mono-species fishery and only *C. garua* were caught.

Observation

River dolphin Oil: Dolphin oil obtained from blubber was mixed with cowdung and was used for the experiment. Altogether about 60 ml of oil was used, and 17-26 fishes (*C. garua*) (Plate 1, Fig. 4) weighing 580-780 g were obtained in the four trials from 0530 to 1100 hr. But the catch was very poor when the operation was carried out during 1100-1500 hr (Table 1). The stomachs of the fishes caught were gorged with the 'lure' indicating that they fed on it.

Crude shark liver oil: Five trials were conducted by using crude shark liver oil (Table 2). The amount of oil used was the same in all the trials and it was conducted simultaneously in different centres keeping the other parameters constant. During the trials with shark liver oil, 31-51 numbers of fishes weighing 940-1720 gm were obtained. There was no marked difference between the crude oil with different acid values. The catches were very poor when the fishing was conducted at noon. Only one fish was obtained in the noon trials.

Sardine oil: The sardine oil was also found to lure the fishes. But it was not as efficient as shark liver oil. The total weight of fishes obtained during the morning operations ranged from 518 to 1080 g

Table 1

RESULTS OF THE TRIALS USING RIVER DOLPHIN OIL FOR FISHING IN GANGES

		Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt.5
	Oil (ml)	60	60	60	60	60
1.	Wt. of Mixture (gm)	300	300	300	300	300
2.	Wt . of Mixture (gm)	200	200	200	200	200
	Duration (hr)	5.30	5.30	5.30	5.30	5.30
	Time: (hr)	0530-1100	0530-1100	0530-1100	0530-1150	1100-1500
	No. of Fishes	17	26	25	22	4
	Length range (mm)	140-190	145-190	142-180	140-175	140-175
	Total weight (gm)	580	760	780	670	170
	Date	12.4.'91	13.4.'91	14.4.'91	14.4.'91	14.4.'91

TABLE 2
RESULTS OF THE TRIALS USING SHARK LIVER OIL FOR FISHING IN GANGES

	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5
Oil (ml)	60	60	60	60	60
Acid value	6.5	20	6.5	20	20
Wt. of mixture (gm)	300	300	300	300	300
Wt. of mixture 2 (gm)	200	200	200	200	200
Duration (hr)	5.30	5.30	5.30	5.30	5.30
Time (hr)	0530-1100	0530-1100	0530-1100	0530-1100	1130-1530
No. of fishes	38	30	43	51	4
Length range (mm)	145-195	140-200	142-210	182-190	180-190
Total weight (gm)	1200	940	1430	1720	150
Date	12.4.'91	12.4.'91	13.4.'91	13.4.'91	13.4.'91

numbering 14-27 fishes (Table 3). But during the operation from 1100 to 1500 hr. only 3 fishes weighing 95 g and length range 145-180 mm were caught indicating that this period was not suitable for the fishing.

TABLE 3
RESULT OF THE TRIALS USING SARDINE OIL FOR FISHING IN GANGES

	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5
Oil (ml)	60	60	60	60	60
Acid value	9.5	9.5	9.5	9.5	9.5
Wt. of mixture 1 (gm)	300	300	300	300	300
Wt. of mixture 2 (gm)	200	200	200	200	200
Duration (hr)	5.30	5.30	5.30	5.30	5.30
Time (hr)	0530-1100	0530-1100	0530-1100	0530-1100	0530-1100
No. of fishes	27	25	18	14	3
Length range (mm)	140-180	135-185	130-190	140-190	145-180
Weight (gm)	1080	950	690	518	95
Date	12.4.'91	12.4.'91	15.4.'91	13.4.'91	12.4.'91

DISCUSSION

The shark liver oil was found to be more efficient than dolphin oil. Shark liver oil, dolphin oil and sardine oil were found to be in that order of efficiency with an average catch of 1518, 843, and 777 g respectively. When the cost of the oil was considered the shark liver oil costs Rs. 35/kg whereas the cost of dolphin oil and sardine oil were Rs. 50/kg and Rs. 15/kg respectively. If we analyse the economics of the operations, the sardine oil will be cheaper as it is only half the price of shark liver oil. It may be stated that the fish oils which are cheaper and easily available than the dolphin oil can be used as fish lure. It is the first time that the effectiveness of fish oils for luring catches in Ganges has been demonstrated. The fishermen stated that up to one quintal of fish were caught in one operation using dolphin oil during the peak seasons of the fishery.

If the fishermen could be convinced that the fish oils could give better results than the dolphin oils, they would go for the fish oils discarding the traditional use of river dolphin oil. This will go a long way in reducing the poaching pressure on the dolphins and help to conserve the Ganges river dolphins.

ACKNOWLEDGEMENT

We are thankful to Mr. Allan Thornton, Environment Investigation agency, London for his help and encouragement.

March 2, 1995

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11. LARGE CORMORANT *PHALACROCORAX CARBO SINENSIS* (SHAW) BREEDING IN THE NILGIRIS

On September 17, 1994 while watching birds at the Glenmorgan headworks damsite (*c.* 1970 m above msl) at the precincts of Ooty town, I noticed small flocks of Large Cormorants flying to and fro regularly towards a certain part of the reservoir. All of them were in full breeding plumage with white flecks on head and neck, yellow gular pouches and white thigh patches. Suspecting them to breed there, I followed their path and was soon able to confirm my suspicions. There were some partially submerged dead trees in the reservoir and on them the birds had nested. I counted 42 nests and all had incubating birds. Close observation revealed that the brooding birds were being intermittently received by their mates. The total number of adult birds seen in the reservoir was around 130 and almost all were in breeding plumage. So it is quite possible that there is a second breeding colony somewhere near, probably elsewhere in the same reservoir. Earlier, as I walked downstream along the Pykara river, I had seen small numbers of these birds fishing in the calmer stretches. In addition, about 20 birds in breeding plumage were noted from the Kamaraj Sagar dam, also situated at the Ooty environs. It seems that the species has fairly established itself and is evidently thriving at the high altitude lakes and reservoir in the Nilgiris.

The large cormorant is normally a denizen of lowland rivers, jheels, reservoirs, tidal lagoons and the like, but is also known to ascend up to considerable elevations in the lakes of Nepal, Ladakh and Kashmir (Handbook 1: 37-38). The species breeds in many localities throughout the country mainly at lowland jheels, though it is suspected to breed in the high lakes of Ladakh and Nepal (SYNOPSIS II Edition: 10-11). But there is no mention of its occurrence and breeding anywhere in the peninsular mountains. Hence this observation at 1970 metres in the Nilgiri mountains is noteworthy.

December 6, 1994

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12. RECORD OF THE PAINTED SPURFOWL, *GALLOPERDIX LUNULATA* (VALENCIENNES) IN RAMGARH SANCTUARY OF DISTRICT BUNDI, RAJASTHAN

Ali and Ripley (1983) in HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN mention that the painted spurfowl (*Galloperdix lunulata*) is not found in Rajasthan. Paul A. Johnsgard in his monumental work-'*The quails, partridges and francolins of the world*' also says that this bird is not found in Rajasthan (page 248). I wish to inform you that the bird has been photographed by me in the Ramgarh sanctuary of District Bundi, Rajasthan (Lat. 25° 27' N and Long. 75° 39' E) on 14.4.87. These birds (one pair) were regularly seen by me between 1985 and 1987. The birds frequented the ruins of the shikargah in the sanctuary and were surprisingly friendly.

November 7, 1994

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Rajasthan Armed Constabulary,
Police Headquarters, Jaipur.

13. PAINTED SPURFOWL, *GALLOPERDIX LUNULATA* (VALENCIENNES) IN RAJASTHAN

Ali and Ripley (1980) while describing distribution of Painted Spurfowl *Galloperdix lunulata* (Valenciennes) mentioned "Not in Rajasthan.....". During my studies on the birds of Sariska National Park, I found it to be common in the forests of Sariska (Sharma 1981). Subsequently, I also observed it in the Jamwa Ramgarh Sanctuary in Jaipur district. Studies of BNHS revealed it's presence at Keoladeo Ghana of Bharatpur (Vijayan 1987).

Dharmakumarsinhji observed and photographed Painted Spurfowl in Ranthambhore National Park (Dharmakumarsinhji and Lavkumar 1972). In June 1992, I observed this bird in the contiguous forests of Ranthambhore National Park, Kailadevi Sanctuary, Sawai Man Singh Sanctuary and Ramgarh Sanctuary of Sawai Madhopur and Bundi districts.

December 21, 1994 ASHOK KUMAR SHARMA
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14. FIRST RECORD OF FRESH WATER CRAB *PARATELPHUSA* SPP. IN THE BARN OWL'S *TYTO ALBA* (SCOPOLI) DIET IN TRANQUEBAR TALUK, TAMIL NADU, SOUTH INDIA

Barn owl's (*Tyto alba*) diet consists exclusively of rodents and other small mammals (Evans and Emlen 1947, Colvin and McLean 1986) such as shrews, moles, gophers, rabbits, mice, rats, flying squirrels, oppossums, lemmings (Parmalee and Klippel 1991), dibbler and dunnart (Dickman *et al.* 1991). Barn owl pellets occasionally revealed the presence of birds and insects (Evans and Emlen 1947) and frogs (Parmalee and Klippel 1991). We have also observed that the barn owl's diet consist of rats, mice, gerbils and shrews. While analysing the pellets of barn owl collected from different nesting sites in Tranquebar Taluk, we had seen the appendages of crab (*Paratelphusa* sp.) as prey remains from a nesting site at Sri Sarntharaikata Swamy temple, Thillaiyadi, during June 1993, and the pellets collected from the site also contained the thoracic chitinous shells and a pair of chelae of freshwater crab. These nocturnal freshwater crabs inhabit the adjoining agricultural lands along with rats. So it may be speculated that the barn owl might have hunted the crabs from the agricultural lands and brought them to the nesting sites for consumption. No such earlier record is available so far from any other region. This observation encourages us to include the crab as one of the food items in the Barn owl's diet.

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15. NESTING IN ANCHOR-PIPE BY BRAHMINY MYNA, *STURNUS PAGODARUM* (GMELIN)

(*With a text-figure*)

On 6.6.1994 at about 12 hr. I was waiting for an Alwar-bound bus at the bus-station at Khairthal in Alwar district when I observed a pair of Brahminy myna (*Sturnus pagodarum*) carrying small insects to feed their chicks in an anchor-pipe, made of steel that was placed to support the anchor-wire of a telephone pole (Fig 1). The length of the pipe was nearly 2 metres. Its lower end was buried in the earth and the upper end was available to the birds to move in and out. The diameter of the pipe was nearly 62 mm posing no problem to the bird's entry. Since summers are very hot in Rajasthan, steel becomes very hot during the day time, specially at noon, even then such a hot site was selected by the birds for nesting. On the date of observation, the maximum temperature was nearly 45°C in the locality. I could see one bird (perhaps female) frequently sitting at the mouth of the pipe in the wing spread posture.

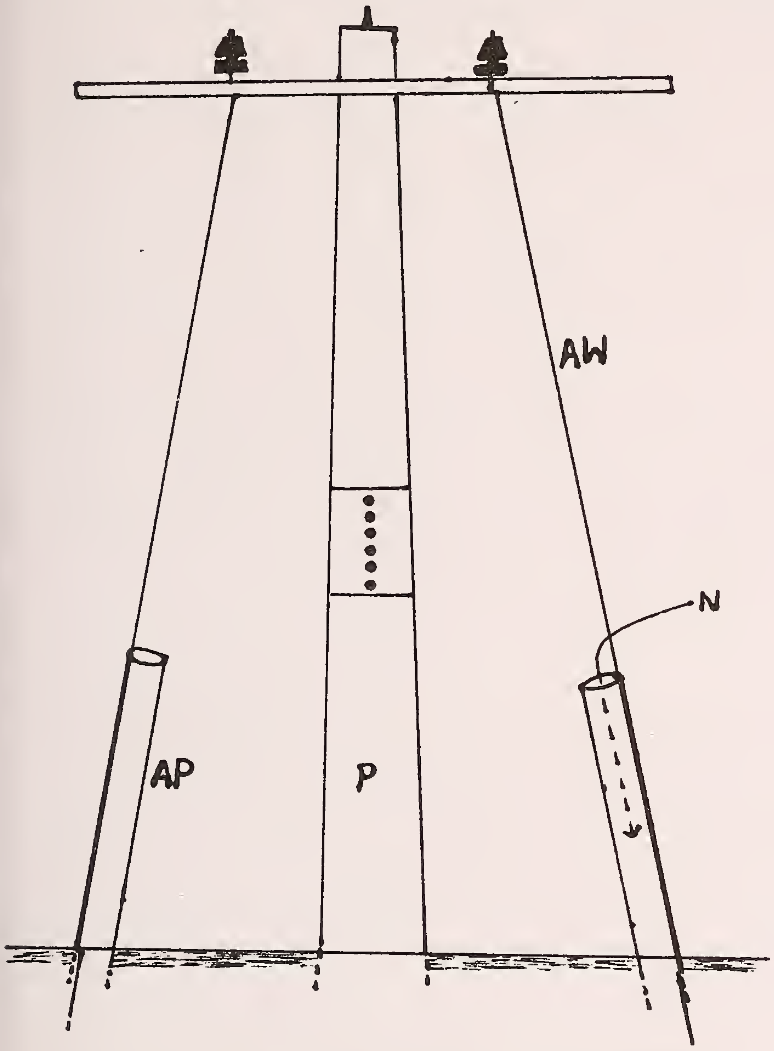

Fig. 1. Nesting site of Brahminy Myna (*Sturnus pagodarum*) in an anchor-pipe. AW-Anchor-wire, AP-Anchor-pipe, P-Telephone pole, N-Nesting site.

According to Ali and Ripley (HANDBOOK 1983) *S. pagodarum* nests in holes in tree trunks or boughs, in a wall or roof of houses. Nesting in steel anchor-pipes is a new site and hence worth placing on record.

January 12, 1995

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16. INTRASPECIFIC BROOD PARASITISM IN THE COMMON MYNA *ACRIDOTHERES TRISTIS* (LINN.)

Intraspecific brood parasitism (IBP) refers to a female laying one or more eggs in a conspecific nest. It is much more common in birds that have self-feeding young than in those where young are fed by parents. Among the latter, it is more common in colonial than in solitary nesting species (Rohwer and Freeman 1987). IBP occurs in 28 passerine species all of which have parentally fed young (Rohwer and Freeman 1987, MacWhirter 1989, Dhindsa 1990). Among Indian birds, this behaviour has been reported in four passerines, all belonging to family Ploceidae (Dhindsa 1983a, b; 1990). In this paper, we describe evidence of IBP in the Common Myna *Acridotheres tristis,* a passerine species of the family Sturnidae in which the young are fed by parents.

Observations were recorded while studying breeding biology of the Common Myna during its 1992 breeding season in the Punjab Agricultural University campus at Ludhiana (30° 56' N, 75° 52' 'E, 247 m above msl). Thirty (15 wooden and 15 polyvinyl chloride) nest boxes were put up in different parts of the University Campus. Two boxes were lost while 22 of the remaining 28 boxes were occupied by the common Myna. The nest boxes were checked twice a week during nest building and daily from the initiation of egg laying till three days after the clutch was completed. To avoid disturbance to the incubating female, nest boxes were not checked for one week after making sure that the clutches were complete. After this, however, boxes were again checked daily.

Evidence of IBP was recorded in one of 22 (4.5%) nest boxes in which Common Mynas bred. The first egg of the clutch in this box was laid on 22 April, followed by three more eggs on 23, 24 and 25 April, respectively. The nest was examined daily up to 28 April but no more egg was found in it. The clutch of 4 eggs was, therefore, completed on 25 April. When checked after a week, i.e. on 5 May, there were five eggs in the box instead of a clutch of four. The fifth egg was thus laid after 28 April, i.e. at least 4 days after the clutch was completed. The size of the fifth egg (28.3 x 21.0 mm) was smaller than the average size of four eggs of the clutch (29.9 x 22.0 mm). Hatching commenced on 7 May when two eggs hatched simultaneously. This suggests that the incubation had started after second egg of the clutch was laid. The remaining three eggs did not hatch and remained intact in the box till 21 May when the young were 14 days old. Both young fledged successfully on 28 May, i.e. 21 days after hatching.

Like most passerines, Common Mynas lay eggs at one day intervals. In the present study, no eggs were ever laid after the completion of clutches in 21 of 22 nest boxes. The eggs in all the boxes were laid at regular interval of 24 hrs except in three cases where one egg of the clutch was laid at 48 hrs interval. In most passerine species, females start incubating just after the penultimate or last egg of the clutch is laid. The eggs appearing in the nest thereafter cannot be taken as laid by the owner female because ovaries and related reproductive organs regress soon after the completion of clutch. Moreover, the usual interval of 24 hr. (rarely 48 hr.) between successive eggs of a clutch of the Common Myna also suggests that the egg laid 96 hr. after clutch completion in this nest box was a parasitic egg.

The reasons of IBP recorded in this study are not clear. However, the smaller size of parasitic egg as compared to the average egg size in the host clutch suggests that this egg might have been laid by a young female (Yom-Tov 1980). The second possibility may be the shortage of suitable nesting sites. This factor is important in species which lay in holes, cavities, burrows and similar places (Yom-Tov 1980). In our study area, 28 nests of Common Myna were in natural holes in trees while the rest were built in tree branches (Sandhu 1993). This suggests that Common Mynas prefer breeding in natural holes which are definitely in short supply in the study area. This is supported by the fact that 22 of 28 (78.6%) nest boxes put up in the study area were occupied by Common Mynas. In 10 nest boxes, they reared two and in 3 nest boxes, three successive broods. One pair even evicted a pair of ring doves *Streptopelia decaocto* from a nest box after the female dove had laid an egg (Dhanda and Dhindsa 1993). All this suggests that the number of mated females may be more than the available nest sites, leading to IBP.

IBP is successful in those birds which are unable to recognize and eject conspecific parasitic eggs (Dhindsa and Sandhu 1988). Common Mynas do not eject their unhatched eggs from the nests. Even the heterospecific eggs are not ejected by them. The evidence of this came from the nest box from where an egg of ring dove was neither ejected nor destroyed by the Common Mynas which evicted the doves and occupied the box to lay their own clutch (Dhanda and Dhindsa 1993). This observation suggests that even interspecific brood parasitism can be successful in Common Myna.

ACKNOWLEDGEMENTS

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14 October 1994

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17. SIDEWAYS LEAP-FROGGING BY THE LARGE GREY BABBLERS, *TURDOIDES MALCOLMI* (SYKES)

Leap-frogging in the Common Babblers (*Turdoides caudatus*) has been recorded by me earlier (*JBNHS* 89: 376), but not so far among the Large Grey Babbler (*Turdoides malcolmi*).

On 11 September 1991 in front of my residence at Sidhi, Madhya Pradesh, four birds were seen perched on an electric line. Suddenly two of them indulged in sideways leap-frogging by performing closely huddled sideways jumps, one over the other, in quick succession. In this manner, they traversed a distance of about a metre on the electric line, thereafter indulged in caressing each other with bills. Before any more observations could be made, the pair flew away.

January 12, 1995

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18. PIPIT (*ANTHUS* SP.) PREYING ON LEECHES

Ponmudi (*c.* 1035 m above msl) is a spur hill of the Southern Western Ghats, about 56 km NE. of Trivandrum. I was watching birds there on 10.7.94 at the edge of an evergreen forest patch which abuts a steep grassy hill side with rocky outcrops and slippery sheet-rocks. Here a Pipit was observed to pick up and swallow a leech from the tip of a grass blade. Within the next thirty odd minutes while I watched it, the bird picked and gulped down two more leeches. Once it even jumped up with wings spread out to capture a leech which was moving at the tip of a leaf blade some 1 m above the ground. The characteristic undulating movement of the leeches might have attracted the bird's attention leading to their predation. While several species of insects together with other arthropods are listed in the dietary of pipits, it seems that leeches have not been hitherto recorded. Moreover such an instance of avian predation on leeches is interesting and seemingly rare.

I was able to watch the bird very closely for a long time using a pair of 8 x 40 field glasses, and from the field characters and call, it was probably the Brown Rock Pipit (*Anthus similis* Jerdon).

October 18, 1994

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19. ON SOME NEW BREEDING RECORDS OF WATERBIRDS FROM THE DELHI REGION

The most comprehensive account of the birds of Delhi region exists in Usha Ganguli's book, *A guide to the birds of the Delhi area* (Ganguli 1975). In this work 404 species are described of which over 150 are recorded as residents, either with breeding records or collected with enlarged gonads. Ganguli's work is largely based on her own observations till her death in 1971 and a compilation of contemporary and earlier records. However, from some of our recent field work in the Delhi region it emerged that some species of waterbirds which have been described as having a "vague" breeding status actually breed in this area. Our coverage of wetland habitats in and around Delhi was broadly the same as in the earlier work, with a few exceptions. In this paper I intend to make a note of these, possibly new breeding records.

1. **Rosy Pelican** (*Pelecanus onocrotalus*)

Ali and Ripley (1983) refer to it as resident, at least in part in the Indian subcontinent and "mainly winter visitor to West Pakistan and North India...". Abdulali and Pandey (1978) record it as a migrant in the Delhi-Agra-Bharatpur triangle while Rai (1983) does not mention it in his checklist of the birds of Meerut region. Ganguli records a couple of instances when Rosy Pelican were seen in large numbers in the wetlands of Delhi region and says, "In December 1969 more than 200 birds were present in Sultanpur jheel; of these 13 or 14 were young birds in brown plumage."

I have seen wild Rosy Pelican breeding in the ponds of the Delhi Zoo (Urfi 1993a). During 1989-1991 I saw their nest on the ground (on islands in the zoo ponds) underneath the canopy of *Prosopis* trees and was informed by the zoo authorities that some of the females among the pinioned pelican's, of the zoo's open-air exhibits, were impregnated by wild males which fly in and out of the premises. Since the early 1990's till now wild Rosy Pelicans have been regularly visiting the zoo and there have been more instances of breeding.

2. **White Ibis** (*Threskiornis aethiopica*)

Ali and Ripley (loc. cit.) record it as resident and nomadic in the Indian subcontinent. Abdulali and Pandey record it as a local migrant/resident while Rai refers to it as a local migrant. Ganguli says, "Occurs at various times of the year, but there was no breeding record for Delhi till September 1, 1969, when P. Jackson found a small nesting colony near Sultanpur Jheel." She does not mention any other nesting record.

I have seen White Ibis nesting in the heronries of the Delhi Zoo along with painted stork, egrets and cormorants. The zoo official's claim that White Ibis started nesting here as a result of the zoo's programme of releasing some captive-bred birds in 1989 (Urfi 1992). During August-September 1992 I saw atleast 23 nests (with chicks in many of them) at Tilyar Lake, about 50 km from Delhi in the Rohtak District of Haryana (Urfi 1993b). Besides these two sites there are several anecdotal accounts of White Ibis nests in the Delhi region.

3. **Lesser Whistling Teal or Tree Duck** (*Dendrocygna javanica*)

In the Indian subcontinent this bird is resident and partial local migrant. Regarding its nesting Ali and Ripley (loc. cit.) mention that it nests mostly in the hollow of trees but also sometimes builds nests on the ground, among reeds and scrub bordering a tank or jheel. Abdulali and Pandey record it as a local migrant/resident in their checklist while Rai records it as a winter migrant in the Meerut region. Ganguli records it as a winter visitor and very uncommon. Regarding its breeding status she says, "In November 1969 during the 10th General Assembly of the I.U.C.N., at one of the outings we saw 4 adults with 6 young birds swimming in Sultanpur jheel. They were at a distance, but Peter Scott identified them as Lesser Whistling Teals, a breeding record after nearly a century."

I have seen Lesser Whistling Teal on several occasions at the Okhla barrage during 1989-1992. On August 26, 1990 I saw a family of 2 adults and 6 chicks swimming in the barrage near the shore. As I walked closer one of the adults climbed the shore and did the 'broken wing/injury display'. While I watched this display the chicks and the other parent had drifted several meters away in the deeper zone of the barrage.

4. **Bronzewinged Jacana** (*Metopidius indicus*)

According to Ali and Ripley, this bird is resident, common and wide spread throughout the Indian subcontinent, excepting Western Punjab and Western Rajasthan. Abdulali and Pandey record it as resident in the Delhi-Agra-Bharatpur triangle while Rai does not record it from the Meerut region. Ganguli records it as a vagrant with only three records from the Delhi region. One of these concerns an immature bird seen twice (on 8th and 23rd March, 1953) at Senipura jheel about 32 km east of Delhi. On another occasion in May 1966 an adult was seen collecting water-weeds in a swamp — the season and its behaviour suggested that it might be nesting.

I have seen Bronzewinged Jacana on several occaions at the Okhla barrage during 1989-1992. In September 1990 I saw 2 adults and 2 juveniles in a seepage pond close to the Okhla barrage. Although this pond was used by local people for cultivating *Trapa* (Singhara) and there used to human disturbance, I saw this family many times.

I thank Suresh Sharma for help in the field and commenting on an earlier draft. I thank CSIR, New Delhi for supporting my studies on waterbirds, at several stages.

January 31, 1995

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20. RECENT ADDITIONS TO THE BIRD LIST OF THE LAKSHADWEEP ISLANDS

In a recent paper, Kurup and Zacharias (1994) have summarized and listed out the birds so far reported from the Lakshadweep archipelago. They have compiled a list of 104 species reported between 1876 and 1992. Earlier, Daniels (1992) had put together a list of birds seen by him and others who visited these islands and related the biogeographical theories to the patterns of bird distribution in the Lakshadweep Archipelago.

The paper by Kurup and Zacharias includes species recorded by us in 1990-91, during the course of our survey of the nesting terns on the Pitti sandbank and some nearby islands. We had seen a total of 48 species of birds (including three unidentified) in the course of four visits and eleven of these are new records for the Lakshadweep Islands. A detailed report on the status of the breeding terns and the conservation measures suggested is published elsewhere (Mathew *et al.* 1991). We now give some details of our sightings of the eleven species recorded for the first time with some comments on their distribution in the adjoining Maldive Islands.

Large(?) Cormorant *Phalacrocorax carbo*

Two birds were seen in flight over Kavaratti on 28 October 1990, close to the helipad, located at the southern tip of the island. Later one of the birds flew closer. We could see the white throat and hooked bill, besides the overall dark plumage. As the sighting was very brief, it is treated as unconfirmed. This species has not been reported from the Maldives (Ash and Shafeeg 1994).

Yellow Bittern *Ixobrychus sinensis*

On 28 April 1991, a single bird was spotted on Bangaram Island, at the pond behind the Casino Hotel. The bird was seen flying to a bush overhanging the water and a few minutes later, it was again seen in flight. This species has been reported twice in the Maldives (Phillips 1963) and more recently an individual was recorded in captivity (Ash and Shafeeg 1994).

Gullbilled Tern *Gelochelidon nilotica*

Single birds were sighted in flight at Agatti (1 November 1990) and at Bangaram (4 February 1991). Strickland and Jenner (1977) say that single birds have been seen in the winter months in the Maldives while Ash and Shafeeg (1994) mention that it is reported to breed there in March-April.

Plaintive Cuckoo *Cacomantis passerinus*

Two birds - a female in hepatic plumage and a normal grey-coloured individual - were seen together in the same area in Kavaratti on all days from 27-31 October 1990. They were seen in the scrub area near the helipad. We were also able to obtain photographs of the birds. On our subsequent visits in January/February and April 1991, we could not locate them despite careful lookout. Phillips (1963) reports two records (in January and November) in the Maldives and there appears to be no recent record.

House Swift *Apus affinis*

On the afternoon of 1 February 1991, we noticed 7-8 House swifts in overhead flight at Kavaratti, close to the boat jetty. They were flying about, hawking insects. Ash and Shafeeg (1994) have cited old records of this species in the Maldives where it occurs in small numbers.

Indian Pitta *Pitta brachyura*

A solitary bird was noticed foraging on the ground, in a coconut grove with a lot of undergrowth at Kavaratti on 29 October 1990. It was not seen on subsequent dates. There appears to be no report of this species from the Maldives.

Collared Sand Martin *Riparia riparia*

A single bird was seen in the company of Common swallows (*Hirundo rustica*), flying and perched on wires on 29 and 31 October 1990, in the southern portion of Kavaratti. A couple of photographs were taken which confirm its identification. This species has been reported in small numbers in the Maldives, usually between September and November and once in May (Phillips 1963, Stickland and Jenner 1977).

Blyth's Reed Warbler *Acrocephalus dumetorum*

We heard and saw three Blyth's reed warblers in the scrub area in the southern part of Kavaratti on 1 February 1991. They were active in the bushes, especially *Lantana*. They were not located on a subsequent trip in April. This species has not been recorded from Maldives.

Tree Pipit *Anthus trivialis*

A single bird was noticed along with Yellow wagtails (*Motacilla flava*) on 27 October 1990 at Kavaratti, foraging on the grassy area close to the lagoon. On 29 October 1990, three birds were seen perched on coconut fronds in the same locality. It has been recorded once in the Maldives (Phillips 1963).

Paddyfield Pipit *Anthus novaeseelandiae*

We saw a single individual near the helipad at Kavaratti on two occasions — on 29 and 30 October 1990. The bird lacked tail feathers. This species has not been reported from the Maldives.

White Wagtail *Motacilla alba*

Solitary individuals were seen at Kavaratti on 30 October and at Agatti on 1 November 1990. No records from the Maldives.

ACKNOWLEDGEMENTS

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21. THE KEELED BOX TURTLE *PYXIDEA MOUHOTII* GRAY ON THE NORTH BANK OF THE BRAHMAPUTRA — A NEW RECORD

The Keeled box turtle *Pyxidea mouhotii* Gray, 1862, is one of the poorly-known hard-shell turtle species of South-East Asia. In India, it is confined to the North-East and has been specifically recorded from North Cachar Hills, Assam, Garo and Khasi Hills of Meghalaya (Das 1991), Mehao sanctuary (Bhupathy and Choudhury 1992) and Namdapha National Park, Arunachal Pradesh (Das 1991). Recently this species has been recorded from Dhansiri reserved forest, Karbi Anglong district, Assam (Choudhury 1993). All these records were from the south of the Brahmaputra river.

On 27 April 1995, I obtained a carapace of keeled box turtle (AUC 39) in Madhupur village of Lakhimpur district in eastern Assam. It measured (in cm): Straight line carapace length=16.35; Curved carapace length= 18.4; Straight line carapace width= 11.8; Curved carapace width= 17.9 and Carapace height= 6.0.

On enquiry, I was told by the villager who collected it live, that it was found in a small hill stream with flowing water in Durpong Reserved Forest of Papum Pare district (formerly part of Lower Subansiri district) of Arunachal Pradesh. The inter-state border is only about a kilometre from Madhupur and the site of original collection was only a few kilometre inside the foothill country. This part of Arunachal Pradesh has been referred to as Daffla Hills in earlier records.

November 23, 1995

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22. REPRODUCTIVE BEHAVIOUR OF INDIAN MUGGER (*CROCODYLUS PALUSTRIS*) AT BHOR-SAINDAN CROCODILE SANCTUARY IN HARYANA

The present study was conducted on the Indian marsh Crocodile at Bhor Saidan Crocodile sanctuary in Kurukshetra District of Haryana State in India 29° 45' N, 76° 44' E. The sanctuary is situated 13 Km West of Kurukshetra on Kurukshetra-Pehowa road. The total area of the sanctuary is 3.25 ha. In the middle of the sanctuary, there is a big earth mound riddled with tunnels, where crocodiles stay at night during winter and lay eggs during the summer. The earth mound is surrounded by a circular water body. The mound is connected to the pond by two longitudinal bunds at the front and back which provides a passage to the mound.

In the centre of the pond, there is a platform,

TABLE 1a

SHOWING INCIDENCE OF PAIRING, MATING, ETC., DURING DECEMBER 1988 TO MARCH 1989

Date of Observation	No. of Pairs seen	Postures
1988		
Dec. 9 & 10	Two pairs	One pair facing each other. Another pair lying near each other.
Dec. 13 & 14	None	--
Dec. 18 & 20	Three pairs	Lying close to each other, facing each other in one pair and another lying parallel to each other.
Dec. 22 & 23	Two pairs	Feet touching each other.
Dec. 26, 27, 28	Two pairs	Left fore foot of male touching right fore foot of female: tails of male and female touching each other.
Dec. 30, 31	none	--
1989		
Jan. 11, 12, 13	Two pairs	Lying near each other.
Jan. 17, 18, 19, 20	none	On 1st two days.
	Two pairs	Only tails of male and female touching each other. Mouth of male touching the tail of the female.
Jan. 28, 29,30, 31	Three pairs	Mouth of one touching the tail of the other, close to each other, parallel to each other.
Feb. 4, 5, 6	Three pairs	Facing each other, mouth of one touching forelimbs of the other, tails of male and female touching each other, forelimbs touching.
Feb. 11, 12, 13	Two pairs	Mouth of male touching tail end of female, forelimbs touching.
		Mating was observed at 5.45 p.m. and lasted for twenty minutes.
Feb. 16, 17, 18	Three pairs	Male and female lying parallel, touching forelimbs.
Feb. 22, 23, 24	Two pairs	Lying parallel, touching forelimbs.
March 8, 9	One pair	Courtship and Mating observed at 11.45 a.m.
March 12, 13	none	--
March 24, 25, 26	none	—
March 29 & 30	none	Females seen digging sand out of tunnels.

TABLE 1b

THE INCIDENTS OF NESTING AND EGG LAYING AT BHOR SAIDAN CROCODILE SANCTUARY DURING 1989

April 3, 4	Dug sand observed at the mouth of two Tunnels.
April 12, 13	No Activity.
April 19, 20	No Activity.
May 8, 9	Two Damaged eggs recovered from the mouth of one tunnel, female was observed guarding the eggs. This guarding of eggs continued up to June 7.
May 27, 28	The Females were still guarding the eggs lying in the tunnels.
June 3, 4	— do —
June 6, 7	The female guarding the eggs from May left the tunnel. No hatchlings were observed.
June 16, 17	— do —
June 18, 19	— do —
June 25, 26	— do —
June 29, 30	— do —
July 1	The female left the tunnel. No Hatchlings were observed.

TABLE 2a

SHOWING INCIDENTS OF PAIRING, MATING, ETC., FROM DECEMBER 1989 TO MARCH 1990

Date of Observation	No. of pairs seen	Posture
1989		
Dec. 14, 15	One pair	Lying parallel and very close to each other.
Dec. 21, 22	Two pairs	Fore and hind feet touching.
Dec. 27, 28	Two pairs	One pair facing each other with heads touching, second pair lying near each other.
1990		
Jan. 4, 5	Three pairs	Mouth of one touching tail of another. In another two pairs male and female were lying near to each other, tails in contact.
Jan. 11, 12	none	—
Jan. 18, 19	Two pairs	In one pair mouth of male was touching the tail of the female and in the other pair mouths were close.
Jan. 25, 26	Three pairs	Limbs touching, the second pair facing each other, mouth of one touching the neck of other, in the third pair tails were touching.
Feb. 2, 3	Two pairs	Probably the mouth of the male was touching tail of the female and in other pair the tails were touching each other.
Feb. 9, 10	Two pairs	Lying parallel to each other, the mouth of male touching the tail of the female.
Feb. 16, 17	Two pairs	Mouth of male touching tail end of female in another pair the limbs were in contact. Mating was observed in one pair at about 3.20 p.m. It lasted for about 25 minutes.
Feb. 23, 24	One pair	Both male and female were lying parallel to each other, heads in contact.
March 2, 3	One pair	Male touching the end of female's tail. Then both moved in the water for courtship and mating at mid day around 1.30 p.m.
March 9, 10	none	—
March 23, 24	none	—

TABLE 2b

THE INCIDENTS OF NESTING AND EGG LAYING AT BHOR SAIDAN CROCODILE SANCTUARY DURING 1990

April 6, 7	Freshly dug sand observed at the entrance of the tunnel.
April 20, 21	An abandoned tunnel was observed to be in use as sand was dug out by the mugger.
May 12, 13	The shells of damaged eggs were collected from the mouth of the tunnel up to June 16.
May 19, 20	The egg laying came to notice in another tunnel from the appearance of damged eggs from the mouth of a tunnel. The female remained in the tunnel up to June 28th.
May 26, 27	Females were still guarding the eggs.
June 3, 4	— do —
June 10, 11	— do —
June 15, 16	One female left the tunnel. No hatchling was observed.
June 27, 28	Another female also left the tunnel. No New born was observed.

which is the main basking site during winter. The sanctuary is completely fenced all around.

The breeding behaviour of the mugger was studied during 1988, 1989, 1990 on a regular basis by making daily or weekly visits as the situation warranted. On several occasions, the stay at the sanctuary site was extended to several consecutive days. But during 1991 and 1992 only a few visits were made to the sanctuary site to study various aspects of the breeding behaviour. Observations were made with the help of binoculars and records made with a camera and on a field note. Care was taken to study the entire area of the Sanctuary on all occasions.

Table 1 accounts for different activities of the breeding periods of 1988-89 and 1989-90. It is evident from table 1 that during the observation the breeding season was between December to July. According to Whitaker and Whitaker (1984) the breeding season in the case of the mugger extends from November to June in Madras in South India. On the other hand, Prakash (1971) has reported mugger breeding from December to May at Jaipur in western India. It is clear that the breeding season varies geographically and it could be broadly generalised to correspond to December to July.

It is also evident from Tables 1 and 2, that the breeding exercise of the mugger is broadly divided into sub phases, namely pre-pair formation activities, pair formation and courtship, mating, egg laying and guarding of eggs.

The pre-pair formation activity is basically a part of basking in the sun during winter. At the onset of winter from October onwards every year crocodiles bask at specific places. At that time they bask in groups of five to six. As the winter progresses the number of crocodiles in each group increases. So the pre-pair formation activity may not be considered a part of the breeding cycle.

In December every year, the groups of basking muggers, segregate into smaller groups, that is, pairs of male and female. This pairing is an extended activity as it lasts for 3 months, from December to February or March. Basically, the pair formation is a courtship activity prior to mating, in which the male follows a female the whole day while basking, venturing into water and both stay in the same tunnel at night. The male and female show intimacy by various action tabulated in Tables 1a & 2a. This intense courtship of 3 months or more leads to mating.

It is pertinent to mention here that mating is a very private exercise wherein male and female become waterborne in deep water in the most secluded corner of their residence.

Mating events could only be woven together focussing on animals under observation, constantly for many days, for many hours, coinciding with the mating season. Any pair preparing to mate on any given day disappears from the basking ground, at least 5-6 hours prior to actual mating. This pair remains water borne for at least 4-5 hours and their movement is not discernible owing to their very composed style of floating. At least half an hour before actual mating, the male starts circling the female, keeping his tail upwards out of water, slightly curved. The snout of the male is always directed towards the female.

This circling continues for 20 minutes or so. The next five minutes of this phase are very crucial and distinctive from the fact that the male and female bite each other by locking their jaws while lying juxtaposed to each other laterally. Mounting takes place in this position, both the animals completely submerge in water, the female submerge first. At this point of time, the male moves his body downwards at the same place where the female is lying in the water. It appeared as if the male and female were copulating belly to belly. After 5-6 minutes, the female was seen biting the head scutes of the male. Later, the male and female moved apart swimming briskly. The observation with regard to the sequence of courtship are somewhat in agreement with the observations of Whitaker and Whitaker (1984). However no hissing sound was audible, as observed by Singh (1979a) and no activity was observed on land as observed by Yadav (1969).

Briefly before actually mating the male circles the female and both bite each other, followed by mating in deep water, the actual mating is not visible.

After courtship, the next activity during the breeding season is nesting. In nesting, the mugger identifies the place for the nest and digs. At Bhor Saidan Crocodile Sanctuary the muggers did not dig fresh nests, but lay in permanent nests that is, the tunnels. The laying of eggs in tunnels has also been reported by Singh (1979b). Before the egg laying the muggers were observed clearing the debris from the mouth of the tunnels. On a few occasions freshly dug sand was also observed at the mouth of the tunnels. This sand was probably dug out to lay eggs in the tunnel.

Every year eggs have been retrieved from 2-3 tunnels in damaged condition. The reason for damage of the eggs has not been identified. This is the sole reason why hatchlings have never been observed in the sanctuary where mortality rate of egg seems to be 100%. It is curious to note that during late May and June, it is very easy to discern the sex of the animal as the females despite the inclement weather, remain confined to the tunnels, in a bid to guard the eggs lying inside the tunnel. On several occassions 4-5 egg shells were seen lying at the mouth of tunnel in which a female was lying.

August 14, 1993

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23. RECORDS OF WATER SNAKES (HOMALOPSIDAE: SERPENTES) FROM GUJARAT STATE

During surveys of snakes in Gujarat State, I received five live water snakes, on February 2, 1988, from local fisherman of Navsari, Valsad District. All were trapped in fishing nets, during fishing in the estuary of Purna river. *Cerberus rhynchops* was the commonest species and there was a specimen of *Gerardia prevostiana*.

C. rhynchops occurs in the estuaries of all big rivers of south Gujarat, but *G. prevostiana* is being recorded for first time from Gujarat.

Measurements and Details: Snout to vent length 52 cm, tail length 8 cm and total length is 60 cm. Supralabials 7, 4th touches the eye; infralabials 9 with two pairs of genials; temporals 1+2; 1 pre, 1 supra and 2 postoculars; body scales smooth and 18:17:15 in row; ventrals 154; subcaudals 35 divided; anal plate 2; sex:male.

Eye small with vertical pupil. Body colour uniformly dark grey, upper lip and lower jaw white and other three rows of body scales are lightgrey, belly white, with the edges being dark grey.

According to Smith (1943, FAUNA OF BRITISH INDIA, Vol. III), this species is distributed in the coasts and in tidal rivers of India, from Bombay to Malabar, and is reported from Sri Lanka (Kalani river), Burma (Gulf of Martaban) and the west coast of Malay Peninsula. The present record from Purna river, 3 km from Navsari, Valsad District therefore extends the range of the species.

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24. COMMENTS ON THE NOTE "FIRST RECORD OF *MICROHYLA RUBRA* (JERDON) (AMPHIBIA: ANURA) FROM MAHARASHTRA" BY KAMBLE AND GHATE

Kamble and Ghate (1994) have recorded *Microhyla rubra* (Jerdon) (Amphibia: Anura) for the first time from Maharashtra based on a specimen available in the Western Regional Station, Zoological

Survey of India, Pune, determined by M.S. Ravichandran. However, the Amphibian specimens available in the Western Regional Station, Zoological Survey of India, Pune have been studied earlier and the results published by Ravichandran and Pillai (1990) through their paper entitled, "Amphibia of Maharashtra with description of a new species of torrent toad, *Ansonia*". Ravichandran and Pillai in their paper cited above have clearly reported *Bufo beddomii, Microhyla rubra* and *Rana keralensis* as new records to Maharashtra and stated that *Microhyla rubra* which was not known north of Malabar (Kerala) in Western India and Bangalore in the Peninsula now enjoys a more extensive distribution, hence the record of interest.

Ravichandran and Pillai (1990) having already reported the occurrence of *Microhyla rubra* in Maharashtra, the recording of the species of Kamble and Ghate (1994) does not form the first record from the area.

Kamble and Ghate (1994) have used the specimen determined by M.S. Ravichandran for their report.

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25. *PUNTIUS DUKAI* DAY (PISCES: CYPRINIDAE) — A NEW RECORD FROM UTTAR PRADESH HILLS

During the course of collection of fishes from Gharhakiya Gad (a tributary of East Ramganga river in Pithoragarh district, altitude 1125 m.s.l.), a few specimens of *Puntius dukai* Day were caught from side pools of torrential streams. Subsequently, 5 specimens were also caught from Ladhiya stream (a tributary of the Kali river system) at Chalthi, Pithoragarh district.

A perusal of the literature on fishes of Uttar Pradesh Hills (Hora 1937, Menon 1949 and Pant 1970) shows that this species was not known from the region.

The occurrence of *P. dukai* from this area extends the distributional range of the species up to U.P. hills, while in earlier studies the distribution of the species was recorded as Teesta river, Darjeeling (West Bengal) and nearby foothills of Terai and Duars (Day 1889, Sen and Jayaram 1982).

A brief discription of the species is given below.

1889, *Barbus dukai* Day, *Fauna Br. India. Fish.* p. 564, pl. CLXVI, fig. 3.

1981, *Puntius dukai* Jayaram, Handbook Freshwater Fishes India)......p. 100 (distribution).

1982, *Barbus dukai* Sen and Jayaram, Rec. Zool. Sur. India. No. 39, Mahseer p. 15.

Local Name: Karanga, Sidhari.

Diagnostic features: D.13(4/9), P. 15, V.9, A.7(2/5), C.19, L.1.28-29, L.tr. 4.4

Head length 4-¾-5, of caudal 4-¾-5, body depth 4-$^1/_3$-5 in total length. Body elongate and compressed. Interorbital space rather convex. Sides of snout and region below eye with large open tubercles. Lower labial fold interrupted. The rostral pair of barbels are slightly longer than the orbit, the maxillary pair almost reach the angle of the opercle.

Maximum size recorded: 14.1 cm.

We are grateful to Dr. P. Das, Director, NBFGR for encouragement. Thanks are also due to Dr. T.K. Sen, ZSI, Calcutta for confirming our identification.

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26. RECORD OF NEW FISHES FROM PERIYAR TIGER RESERVE

The Periyar Lake, a man-made impoundment and associated streams are situated within the Periyar Tiger Reserve (9° 15' to 9° 40' N; 76° 55' to 77° 25' E) of Kerala. The lake has a total area of 26 sq. km, and two third-order streams, namely Mullayar and Periyar debouch into the reservoir. The lake and associated streams support a diverse fish fauna.

As a part of the study on the structure of fish communities in the lake and associated streams, fishes were collected seasonally from the lake and streams during May, 1994 and April, 1995. The analyses of fish collections revealed the presence of six new species of fishes in the Periyar Lake which were not listed in the earlier investigations (Raj 1941a, b; Chacko 1948) in this area.

The following is the list of new fish species:

1. *Cyprinus carpio communis* Linnaeus
2. *Oreochromis mossambicus* (Peters)
3. *Garra mcClellandi* (Jerdon)
4. *Bhavania australis* (Jerdon)
5. *Noemacheilus guentheri* Day
6. *Travancoria jonesi* Hora

Of these, *C. carpio communis* and *O. mossambicus* are exotic and were distributed abundantly in the lake. Since no records are available with the Forest and Fisheries Departments of the State about the introduction of these exotic species, these fishes are considered to be "accidentally introduced" during the last few decades. Another fish species *G. mcClellandi*, which was distributed both in the lake and streams, has only been reported from Cauvery basin (Talwar and Jhingran 1991). The rest were loaches distributed rarely in the stream and in the confluence zone, where the streams join the lake. Silas (1952) noted the presence of *N. guentheri* and *T. jonesi* in the high range of Travancore which were collected from different streams that drain outside the Periyar Tiger Reserve. One of the rare loaches collected from Periyar, *T. jonesi* has been considered as endangered (Menon 1993). The specimens are kept in the Wildlife Biology Division of Kerala Forest Research Institute.

ACKNOWLEDGEMENTS

The project is supported by the Wildlife Wing of the Kerala Forest Department and we thank the Officials of the Department for their kind co-operation and the Director of KFRI for constant encouragement and guidance.

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27. BIOLOGY OF *ALTICA COERULEA* (OLIV.) (CHRYSOMELIDAE: COLEOPTERA) — A POTENTIAL BIO-CONTROL AGENT AGAINST *JUSSIAEA REPENS* L.

(*With two text-figures*)

The present communication deals with the first report on the larvae and adults of leaf beetle, *Altica coerulea* (Oliv.) (Fig. 1a, b) (Order Coleoptera, Family Chrysomelidae, sub family Alticinae) as a potential bioagent for the control of water primrose *Jussiaea repens* L. in the water bodies of fisheries interest. Studies carried out at the Central Institute of Freshwater Aquaculture, Kausalyaganga indicate that the larvae and adults of the beetle do not attack any other plant of economic importance. The entire life cycle of this beetle is completed within 62-78 days in the spring (at temperature range 16.0-35.5°C). Elongated yellow eggs (Size 93-94 μm x 36-38 μm) are laid horizontally in patches (8-11 patches) on the ventral side of the host leaves for 72 hours consecutively. The dull black 1.5-1.7 m larva hatches out after 6-7 days of incubation and starts feeding voraciously on the tender parts of the *Jussiae* plant. This larva grows up to 9-11 mm in 21 days, when it can consume 31-39 mg of leaves and tender stems per day (i.e. nearly 250-280% of their body weight). At dearth of fresh leaf as a result of total grazing by themselves, larvae bore into the stem wall and excavate tunnels along its length, sometimes traversing internodes, making larval galleries, where they may eventually pupate. After actively feeding for 21-24 days full-grown larvae (12-14 mg) become bowed and cease feeding for one day, then they undergo pupation. The event takes place nakedly by means of a split down the pre-abdomen and the pupa gradually works the larval skin forwards until it forms a crumpled mass at the oral extremity. The light yellow coloured pupae (9-10 mg) metamorphose into adults in about 4 days. The image is 5-6 mm long and 13-15 mg in weight. There is little difference between adult males and females, the males are comparatively small and metallic violet-black in colour, while females are metallic greenish black. Life span (at 16.0°-35.5°C) is over 57 days. Aestivation occurs in moist places under grass clumps and dry leaves on ground. The beetles migrate to nearby infested water bodies, only when the host plants become meagre. They are hardy and vigorous defoliators, making holes in leaves (consumption per day 16-24 mg/beetles). Artificial hibernation over 50 days can be imposed by keeping them at low temperature (4-5°C) in a closed moist bottle, with complete resumption to normal life when

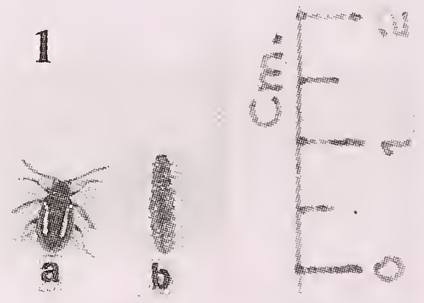

Fig. 1.a. Imaginal and b. larval form of the leaf beetle, *Altica coerulea* (Oliv.).
Fig.2. Control of *Jussiaea* in a fish pond by leaf beetle.

normal conditions are restored, which suggests easy storage of inoculum and transport for dissemination. The fecundity of this beetle has been recorded to range between 140 and 160 (SD-3.35). Adults copulate in overlapping position and the male usually dies after mating. Females lay eggs in batches (14-23 in a batch) and males copulate atleast 8-10 times in the intervals during oviposition. The imaginal form has been found most suitable for inoculation in *Jussiaea* infested ponds where they multiply efficiently and establish themselves. Beetles and their larvae start devastation from inoculation sites and gradually spread all over (Fig. 2). Their grazing verge can be demarcated apparently beyond which the gravid female lays eggs and thus facilitates dispersal. Repeated grazing by both larvae and adults lead to eradication of this weed from water bodies.

This beetle has been found throughout the year but in summer its population gradually diminishes with the increasing intensity of temperature which only adults can withstand, aestivating under suitable shelter. With the onset of rains they efficiently start propagating and become most effective during winter months, when the host plant's growth period is at the peak. Except some larvivorous fishes, so far no natural enemies have been met with during the extensive field observations.

Control of excessive growth of aquatic vegetation is a major problem. Chemical, manual and mechanical control methods can be too expensive, while biological control of weeds is not only efficient but also ecologically acceptable and economically viable. Though, insects have been used for biological control of noxious aquatic plants (Robson 1968, Chaudhuri and Janaki Ram 1975, Jayanth and Nagarkatti 1986 and Sar 1991), no satisfactory bioagent is known to control water primrose, *Jussiaea repens* L. a marginal floating aquatic weed of freshwater ponds. The present studies reveal the potential of *Altica coerulea* beetle and its larva as a bio-control agent for water primrose, being hardy and easy to transfer to the host plant in different localities where it readily propagates.

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We are grateful to Dr. S.D. Tripathi, the former Director of CIFA, Kausalyaganga for his encouragement and suggestions. Thanks are also due to Dr. M.D. Mehrotra, Head, Division of Forest Protection, FRI, Dehradun for identification of the beetle. The kind help of Dr. C.R. Basu, Division of Coleoptera, ZSI, Calcutta for suggesting the new generic name of the beetle is gratefully acknowledged.

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28. STUDY OF MALE GENITALIA OF SOME SPECIES GENUS OF *PHEROPSOPHUS* (BRANCHININI: CARABIDAE: COLEOPTERA) AND ITS TAXONOMIC IMPORTANCE

(*With three text-figures*)

Pheropsophus (Soiler), commonly known as the bombardier beetle, is widely distributed in India. Andrews (1935) placed it under the subfamily Harpalinae. In recent taxonomic studies considerable importance has been given to genitalia (Sewak 1985). However, male genitalia of *Pheropsophus* has not been studied. The male genitalia of three species, namely *P. catoirei* (Deg.), *P. heloris* (Fal.) and *P. lineifrons* (Chaud.) have been described and illustrated in this paper.

MATERIALS AND METHODS

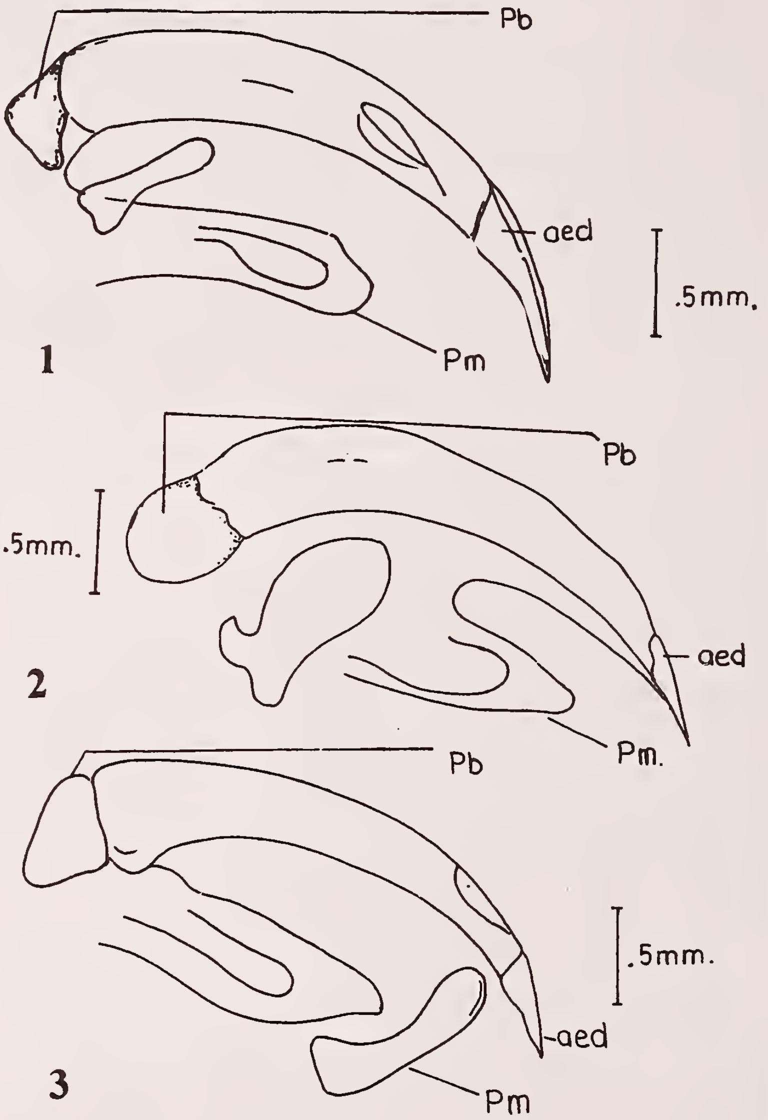
Specimens of *Pheropsophus catoirei* (Degean), *P. heloris* (Failer) and *P. lineifrons* (Chaud.) were collected from different forests, rural and urban localities of western Uttar Pradesh. To study the male genitalia, dried and live specimens were used. The dried specimens were placed in boiling water and their abdomens treated with 10% KOH solution overnight, were dissected out to expose the genitalia and mounted in Canada balsam. The drawings were made with the help of camera lucida attachment.

Observations: The structure of phallobase, aedeagus and parameres (Tuxen 1956) of all the three species reported here greatly differed and the main differences are as follows:

Pheropsophus catoirei (Degean): Aedeagus slender and narrow at the apex, well arcuate, rather abruptly bent near the base than almost straight; phallobase short, triangular and broad in the middle; parameres elongated, right paramere narrow, sides sub-parallel and rounded at apex, left paramere rounded at the apex basically broad and bilobed (Fig. 1).

P. heloris (Failer): Aedeagus small, pointed, at the apex, bent near the base; phallobase rounded, broad in the middle; left paramere oval, broad, rounded at the apex, right paramere narrow, sides sub-parallel and pointed at the apex (Fig. 2).

P. lineifrons (Chaud.) (Fig. 3): Aedeagus long, straight, pointed at the apex, broadly towards the base; phallobase triangular, broad in the middle; left paramere narrow, sides sub-parallel and pointed at the apex, right paramere oval, obtusely pointed at apex.



Male Genitalia of *Pheropsophus* (1 mm=3 cm):
Fig. 1. *P. catoirei*; Fig. 2. *P. heloris*; Fig. 3. *P. lineifrons*.
Abbreviations: Aed: Aedeagus; Pb: Phellobase;
Pm: Paramere.

KEY TO IDENTIFY SOME OF THE INDIAN SPECIES BASED ON MALE GENITALIA

1. Parameres elongated, pointed proximally; Phallobase oval; Aedeagus elongated .... *catoirei* (Deg.)

— Parameres not elongated, phallobase rounded, aedeagus not elongated 2

2. Parameres rounded in the middle; Phallobase triangular shaped; Aedeagus small .... *heloris* (Failer)

3. Parameres broad in the middle, phallobase oval, aedeagus pointed .... *lineifrons* (Chaud.)

TAXONOMIC IMPORTANCE

The oval shaped parameres and long pointed aedeagus of male genitalia of genus *Pheropsophus* show resemblance to other genera of Harpalini, whereas the structure of parameres and aedeagus greatly differs at both generic and species levels. Parameres of *Chlaenius* are elongated, and narrow whereas they are elongated and hairy in *Trechus* and *Tachys,* and pointed and with bristles in *Abacetus.* Aedeagus of *Diplocheila* is broad apically and narrow proximally. The oval shaped paramere and long pointed aedeagus of the studied species of the genus *Pheropsophus* resemble and show similiarities with those of other genera of the family Carabidae.

ACKNOWLEDGEMENTS

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29. CILIATE INFESTATION ON THE PHYTAL HALACARIDAE (ACARI) FROM THE KOVALAM BEACH (KERALA COAST)

The epibiontic ciliate infestation on the macrofaunal assemblages of Pelagial, benthal and phytal realms in the marine environment are well known. However, the epibiontic ciliate infestations on the meiofauna and their impact on the eco-biology of the meiofauna are less known.

Hagerman (1966, *Ophelia 3*: 1-43) reported an unidentified species of Halacaridae (Acari) infested by ciliates found among the phytal sediments of *Fucus serratus* from Oresund.

While studying the phytal meiofauna from the Kovalam beach (Kerala coast), some halacarids were observed to be heavily infested by peritrichous ciliates and are reported here. The present observation is of relevance in the ecobiology of the phytal Halacaridae which are known to serve as food for higher trophic levels in the littoral environments.

TABLE I
PERCENTAGE COMPOSITION OF CILIATE INFESTATION IN DIFFERENT HALACARID SPECIES

Name of Species		July 1987	October 1987
Rhombognathus scuttutus	Male	40	30
	Female	15	13
R. papuensis	Male	5	40
	Female	40	17
Rhombognathus nymphs and larvae		0	0
Copidognathus spp.		0	0
		0	0
Agauopsis brevipalpus brevipalpus		0	0

Among different species of Halacaridae, many *Rhombognathus scuttutus* and *R. papuensis* were infested by ciliates. The ciliate infestation, both qualitatively and quantitatively appears to be influenced by the relative size of the meiofaunal host and its taxonomic position. Ciliate infestation was absent in *Copidognathus* spp. and *Agauopsis brevipalpus brevipalpus* (Table 1). *Rhombognathus* larva and nymph were also not found infested by the ciliates.

The number of ciliates per halacarid ranged between 8-10. The attachment of the ciliates is confined to the exo-skeleton or cuticular zones of the host.

The impact of the ambient biotic and abiotic parameters besides the physiogonomy of the phyta on the epibiontic infestation needs investigation. The halacarid found in the sandy habitat (Psamobiont form, interstitial form) were devoid of ciliate infestation. Most probably, the physical angularities of the sand grains cause attrition and dislodgement or abrasion of the attached epibiontic life while the host animal burrows into the sediments. However, the phytal sediments studied from the Kovalam beach are sandy in nature. The canopies of the littoral phytal realm appear to act as shock absorbers against wave action. The physical frictional force of attrition of the sand grains is ameliorated, facilitating settlement of epibiontic life.

The ciliate infestation on the meiofauna may possibly affect their competitive ability, reproduction, locomotion and bio-energetics.

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30. *DELPHINIUM ALTISSIMUM* WALL. (RANUNCULACEAE) — A NEW RECORD FOR SIKKIM HIMALAYA

(*With a text-figure*)

During my recent plant survey of West Sikkim in September 1994, I came across a *Delphinium* Linn. in Sardong. The plant was identified as *Delphinium altissimum* Wall. which had not been recorded earlier from Sikkim Himalayas. The voucher specimens are deposited in the herbarium of the Botanical Survey of India, Gangtok.

The description of the species along with a diagram (Fig. 1) is given below.

Delphinium altissimum Wall. in Hook. J.D., Flora British India 1:126.1888.

Plant 69-106 cm tall. Stem terete but slightly grooved on one side, sparsely hairy, much branched, with few dimorphic leaves. Radical leaves 2-4, with 20-34 cm long petioles; lamina 5-13 x 6.3-15 cm. broader than long, 5-7 fid, lobes broadly cuneate 3-lobed, coarsely toothed, cordate at the base, 5-7 nerved, pale green above and whitish green below, puberulous. Cauline leaves sessile, linearly branched, 3-lobed, entire, alternate, sparsely hairy. Inflorescence a receme, 7-18 cm long, terminal or axillary; receme 2.5-9 cm long with 2-6 pedicellate flowers, terete, sparsely hairy; Peduncle 4.5-9 cm long, terete sparsely hairy; ovary 1.1-2.5 cm long with 2-3 linear bractioles. Flowers 2.5-2.6 cm across or 2.8-3 long, whitish blue, sparsely hairy, spread-ing with 2 cm long spur behind. Spur subulate, slightly incurved, sparsely hairy. Sepals 5 free; dorsal sepal 2.65-2.7 x 0.6-0.8 cm, sparsely hairy externally elliptic-ovate, apiculate tip with tubular base enclosing spur; lateral sepals 4, unequal, elliptic-oblong, upper whitish blue with a small ochraceous patch at the tip; upper two sepals 1.35-1.4 x 0.7-0.18 cm, lower two sepals 1.48-1.5 x 0.55-0.6 cm. Petals 4, in equal pairs; anterior pair hairy; obtusely 2-lobed, 1.1-1.2 x 0.35-0.4 cm with narrow stalk behind, posterior pair linear 2 toothed infront, whitish blue with dark blue patch at the tip *c* 2.5 cm long. Stamens many, *c* 6 mm long, curved with dark blue bithecal anthers. Staminodes many, enclosed. Pistil 4 mm long, green, glabrous; stigma simple; ovary single celled.

Flowering time: September
Altitudinal Zones: 1220-1525 m.
Distributional status: Rare.
Ecology: It grows on rock crevices along with, *Didymocarpus* sp., *Setaria* sp., *Arundinella* sp. and *Begonia* sp.

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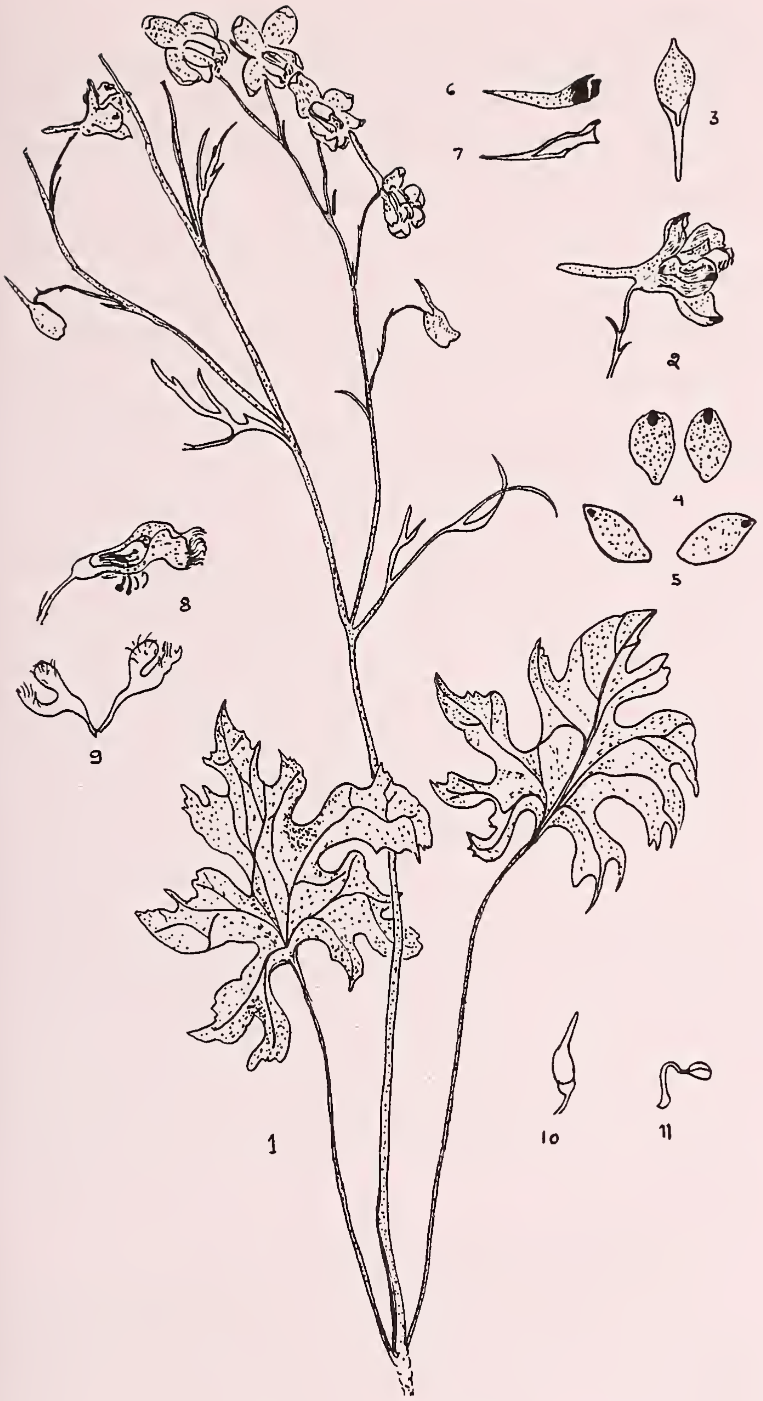

Fig. 1. *Delphinium altissimum* Wall.
1. Whole plant; 2. Single flower; 3. Dorsal sepal; 4-5. Lateral sepal; 6. Posterior petal; 7. Sectional view of posterior petal; 8. View of petal and stamen; 9. View of anterior petal; 10. Pistil and ovary; 11. Stamen.

31. *PYCNOPLINTHOPSIS BHUTANICA* (HARA) JAFRI (BRASSICACEAE): A NEW RECORD FROM WEST HIMALAYA

(*With a text-figure*)

Pycnoplinthopsis bhutanica (Hara) Jafri (Brassicaceae) has been considered endemic to Eastern and Central Himalayas, confined to the alpine zones of Bhutan, Sikkim and Nepal (Hara 1968, 1971, 1979; Jafri 1972, Grierson and Long 1984, Polunin and Stainton 1984, Ohba 1988). However, Sharma and Balakrishnan (1993) have not described it from India. Polunin and Stainton (1984) have also quoted it as "rare but remarkable plant locally abundant en route to Anapurna South base camp, Nepal." The recent discovery of this species from Garhwal, West Himalaya in Indian territory is of considerable phytogeographical interest. A short description of the species is included in this communication along with illustration.

Voucher specimens after proper documentation are deposited and maintained in Herbarium, Department of Botany, HNB Garhwal University, Srinagar-Garhwal (GUH).

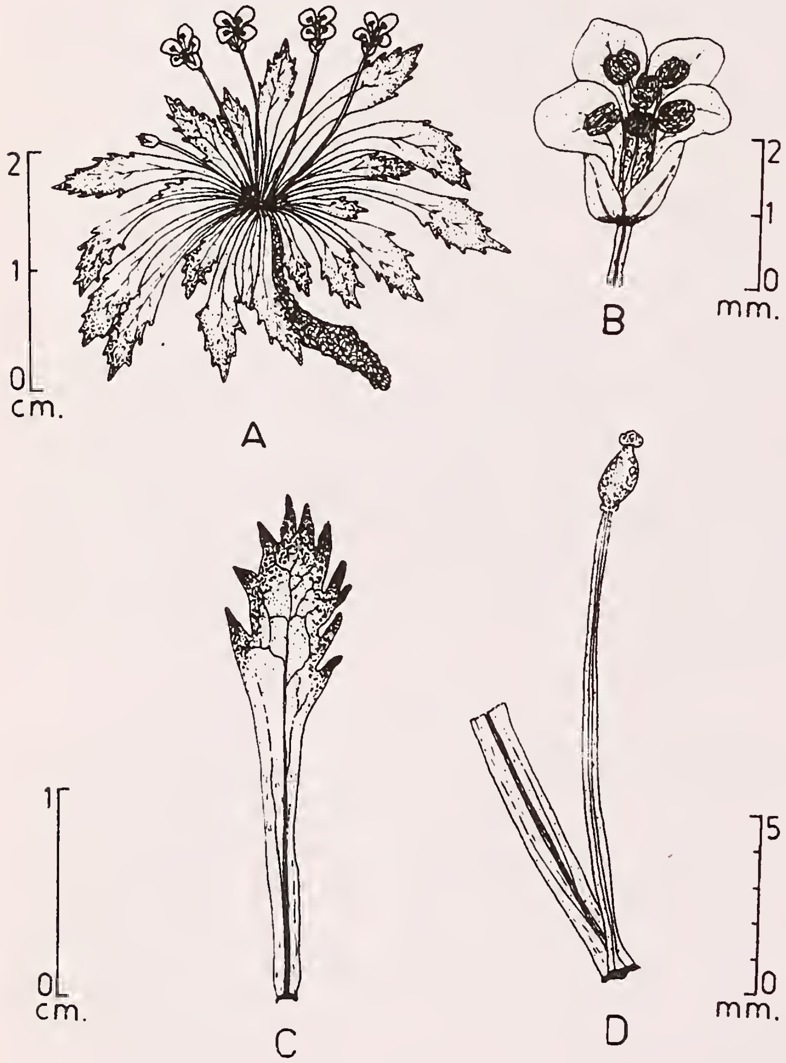

Fig. 1. *Pycnoplinthopsis bhutanica* (Hara) Jafri
A. Flowring plant; B. Flower; C. Leaf; D. Scape and Ovary.

Pycnoplinthopsis bhutanica (Hara) Jafri (Brassicaceae) in Pak. J. Bot. 4:74.1972; Hara, En.Fl.Pl. Nepal 2:44. 1979; Grierson and Long, Fl. Bhutan 1(2):440. 1984; Polunin and Stainton, Fl. Himalaya. 40.1984; Ohba, The Himalayan Pl. 1:37.1988. *Pegeophyton bhutanicum* Hara in J. Jap. Bot. 43:45.1968; *Pycnoplinthopsis minor* Jafri in Pak. J. Bot. 4:76.1972.

Perennial herbs with short unbranched rootstock up to 0.5 cm thick. Leaves all radical, densely rosultate at the apex of rootstock, rosette of radical leaves 2.0-4.0 cm across, leaves spathulate, gradually narrowing down to base, with several (usually 8-12) sharp teeth at the proximal end, 2.0-2.5 x 0.4-0.75 cm, mid vein distinct and much branched in proximal part, basal part translucent. Scapes filiform, glabrous, translucent, up to 2.0 cm long, arising from the axil of leaves, slightly connate to leaves at the base, much shorter than the leaves. Flowers small, 2.0-3.0 mm across, white. Sepals 2.5-3.0 mm x 2.0-2.5 mm, ovate, rounded, one nerved. Petals spathulate, shortly clawed, 3.0-4.0 x 2.0-3.0 mm, much larger than the sepals. Nectariferous gland not distinct. Stamens 6 (4±2), 2 mm long including anthers, filament linear, flat, one nerved, anthers blackish, rounded. Ovary short, stigma broad, capitate, slightly lobed. Seeds (immature) compressed, rounded to reniform, 0.25 mm across, (mature fruits not seen). (Fig. 1, A-D).

Flowering: July-August.

Distribution: Bhutan, Sikkim, Nepal in alpine zones. Recently collected by the senior author from Garhwal Himalaya, at an elevation of 4800 m.

Specimens Examined: INDIA, U.P., Chamoli dist., Shilla Samudra, 4,850 m a.s.l., July, 1991, *D.S. Rawat* 19,790 (GUH); INDIA, U.P., Chamoli dist., Roopkund area, August, 1993, *D.S. Rawat* 21,007 (GUH). A small population at both the sites were observed.

Acknowledgements

We thank the authorities of BSI, Northern circle, Dehra Dun for providing Herbarium and Library facilities. Sincere thanks are also expressed to Prof. M. Quiser, Karachi Univ., Pakistan and Dr. H. Ohashi, Tohoku University, Japan for providing literature on the species. Financial assistance to the senior author (DSR) from UGC New Delhi is also thankfully acknowledged.

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32. *KOSTELETZKYA VITIFOLIUS* (LINN.) COMB. NOV.

(*With a text-figure*)

Borssum (1966) places *Hibiscus vitifolius* Linn. under genus *Hibiscus* section *Pterocarpus* Garcke (1849). He mentions *H. vitifolius* Linn. as the type of the section *Pterocarpus* Garcke (1849).

Borssum (1966), has not mentioned the type species of *Kosteletzkya* Presl.

Mattei (1917), in fact had suggested separating Garcke's section *Pterocarpus* into a separate genus. After publication of *Kosteletzkya* Presl. (1835), Kearney (1955), thought perhaps *H. vitifolius* L. can be considered as belonging to a separate genus (sect. *Pterocarpus* Garcke*),* intermediate between *Hibiscus* and *Kosteletzkya.*

Bentham and Hooker (1862), listed 26 species under *Kosteletzkya.* After considering facts it is clear that Hochreutiner (1955) was correct considering sect. *Eucosteletzkya* Hochr. as identical with herbaceous species of sect. *Pterocarpus* and can be separated on the basis of alate or angular capsules.

Genus *Kosteletzkya* Presl. (1835) was originally described and accepted by Hochr. (1955) with respect to the alate or angular capsules.

However, Borssum (1966) emphasised the character of single ovule per carpel in 5-carpellate ovary. This differentiation on the basis of 1-seeded carpels in *Kosteletzkya* in comparison to 2-5 seeds per carpel in *Hibiscus* is definitely an artificial generic segregation. If *Kosteletzkya* is segregated on the basis of single seed, then genus *Hibiscus* L. will have to be divided at least into 3 more genera on the basis of the number of seeds per carpel. Seeds in various species of *Wissandia* Medik. vary from 1-3 per carpel. Similarly *Abutilon* Gaertn. also contains species with 1 to many seeds. With the segregation character adopted by Borssum, these genera will require to be divided into more genera. Hochreutiner (1955), included species with alate and angular seeds under genus *Hibiscus* sect. *Eucosteletzkya* Hochr. including species resembling *Hibiscus* sect. *Pterocarpus* Hochr.

Therefore the genus *Kosteletzkya* should be restricted to the species with angular capsules and not to the species with single seeded capsules as suggested by Borssum.

Therefore, the following new combination has been proposed:

Kosteletzkya vitifolius (Linn.) Almeida & Patil.

March 9, 1995
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REFERENCES

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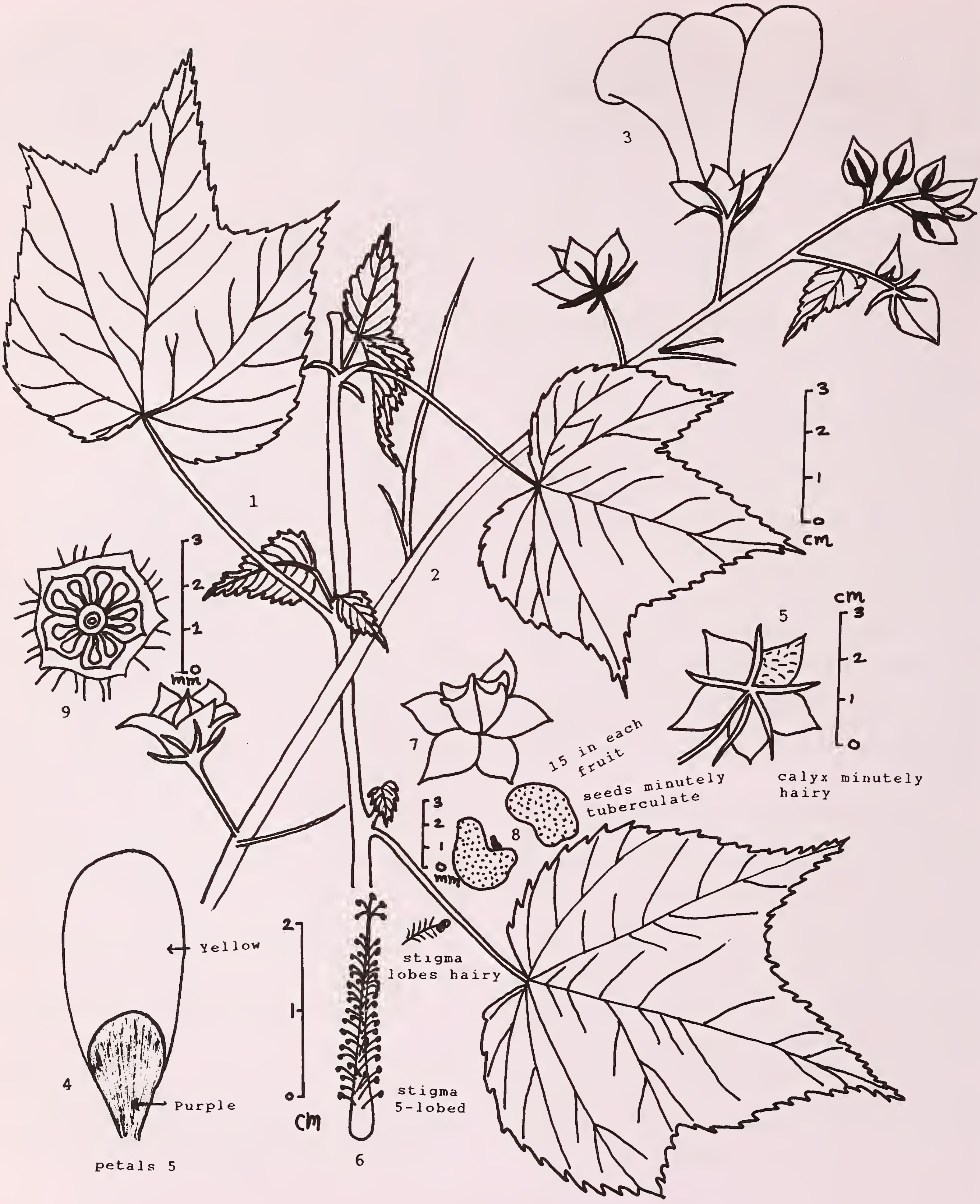
* GARCKE, A. (1849): Kristische Bemerkungen Zuder familae der Mavaceen nebst Benschreibung neuer Artenaus derselben. *Bot. Zeit. 7*: 836.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1
2
3
2
1
0
cm
3
2
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0
mm
9
cm
5
3
2
1
0
7
15 in each fruit
seeds minutely tuberculate
calyx minutely hairy
3
2
1
0
mm
8
Yellow
2
1
0
cm
stigma lobes hairy
stigma 5-lobed
4
Purple
petals 5
6

Fig. 1. *Kosteletzkya vitifolia* (Linn.) comb. nov.
1. & 2. Twig; 3. flower; 4. petal; 5. calyx; 6. staminal column; 7. fruit; 8. seeds; 9. pistil, t.s.

*Hochreutiner, B.P.G. (1955): Flora de Madag. et des Comores. *Fam. 129*: 98.

*Kearney, T.H. (1955): *Leafl. West. Bot. 7*: 272-273.

*Mattei, C. (1917): *Bol. Ort. Bot. Palermo n.s. 2*: 71.

*Presl, K.B. (1835): *Reliq. Haenk. 2*: 130, t. 70.

* Not referred in original.

33. SOME NEW RECORDS OF LEGUMES FROM GARHWAL HIMALAYA

(*With six text-figures*)

During recent plant explorations in remote localities of Garhwal Himalaya we collected some interesting Fabaceae. After critical study and thorough checking of the literature the specimens have been identified as of species which are new records for the Garhwal Himalaya.

The present communication gives illustrations of the newly recorded taxa, highlighting flowering and fruiting period, habitat, occurrence, approximate distributional range and availability, and collectors herbarium number. The plant specimens after identification were matched with the authentic specimens at the Botanical Survey of India, Northern Circle, Dehradun (BSD) and Forest Research Institute, Dehradun (DD) and deposited in the Department of Botany, H.N.B. Garhwal University (GUH), Srinagar Garhwal.

Astragalus cashmirensis Bunge, Mem. Acad. Sci. St.-Pet. ser. 7, 11:30. 1868 & 12: 34. 1869; Baker in Hook. f., FBI. 2: 127. 1876; Sanjappa, Leg. Ind. 85. 1992. (Fig. 1, A-B).

Flowering and fruiting: July-September.

Distribution: Bhelpuri, Tehri Garhwal, 2800 m a.s.l.

Ecology: Rare, a few plants along waysides in dry as well as moist localities, associated with *Polygonum* sp., *Geum* sp. and grasses.

Specimen examined: L.R.D., GUH-12,314.

Notes: Hooker (1876) and Sanjappa (1992) reported this taxon from Kashmir Himalaya. This is a rare collection as well as new record from Garhwal Himalaya, representing its eastward distribution.

Crotalaria burhia Huch.-Ham. (in Wall., Cat. 5386. 1831-1832, *nom. nud.*) ex Benth. in Hook., London J. Bot. 2: 474. 1843; Baker in Hook. f., FBI. 2: 66. 1876; Sanjappa, Leg. Ind. 117. 1992. (Fig. 2, A-B).

Flowering and fruiting: February-March.

Distribution: Tapovan, Chamoli Garhwal, 1750 m a.s.l.

Ecology: Rare. A limited number of plants occur along roadsides on slopes in dry places and this taxon is associated with *Berberis* sp., *Indigofera* sp. and some grasses.

Specimen examined: L.R.D., GUH-12,251.

Notes: Hooker (1876) reported this species from Punjab, Afghanistan, and Pakistan. This taxon has not been collected from Garhwal and Kumaon Himalaya earlier.

Dalbergia latifolia Roxb., Pl. Corom. 2: 7, t. 113. 1799; Baker in Hook. f., FBI. 2: 231. 1876; Duthie, F.U.G.P. 1: 263. 1903; Sanjappa, Leg. Ind. 137. 1992. (Fig. 3, A-B)

Flowering and fruiting: March-June.

Distribution: Ghasi Ram Naala, Pauri Garhwal, 500 m a.s.l.

Ecology: Uncommon. A limited number of plants have been collected from open fields in dry localities, associated with *Shorea robusta, Tectona grandis, Pyrus pashia* and *Mallotus* sp.

Specimen examined: L.R.D., GUH-12,204.

Notes: Hooker (1876) and Duthie (1903) reported it from Western Peninsula, Sikkim, Chota Nagpur, and Bundelkhand. However, Sanjappa (1992) mentioned its occurrence in Uttar Pradesh, West Bengal, Nepal and Malaysia. This is a new record for Garhwal as well as Kumaon Himalaya.

Desmodium tortuosum (Swartz) DC., Prod. 2: 332. 1825; Babu, Herb. Fl. Dehradun 137. 1977; Sanjappa, Leg. Ind. 162. 1992. (Fig. 4, A-C).

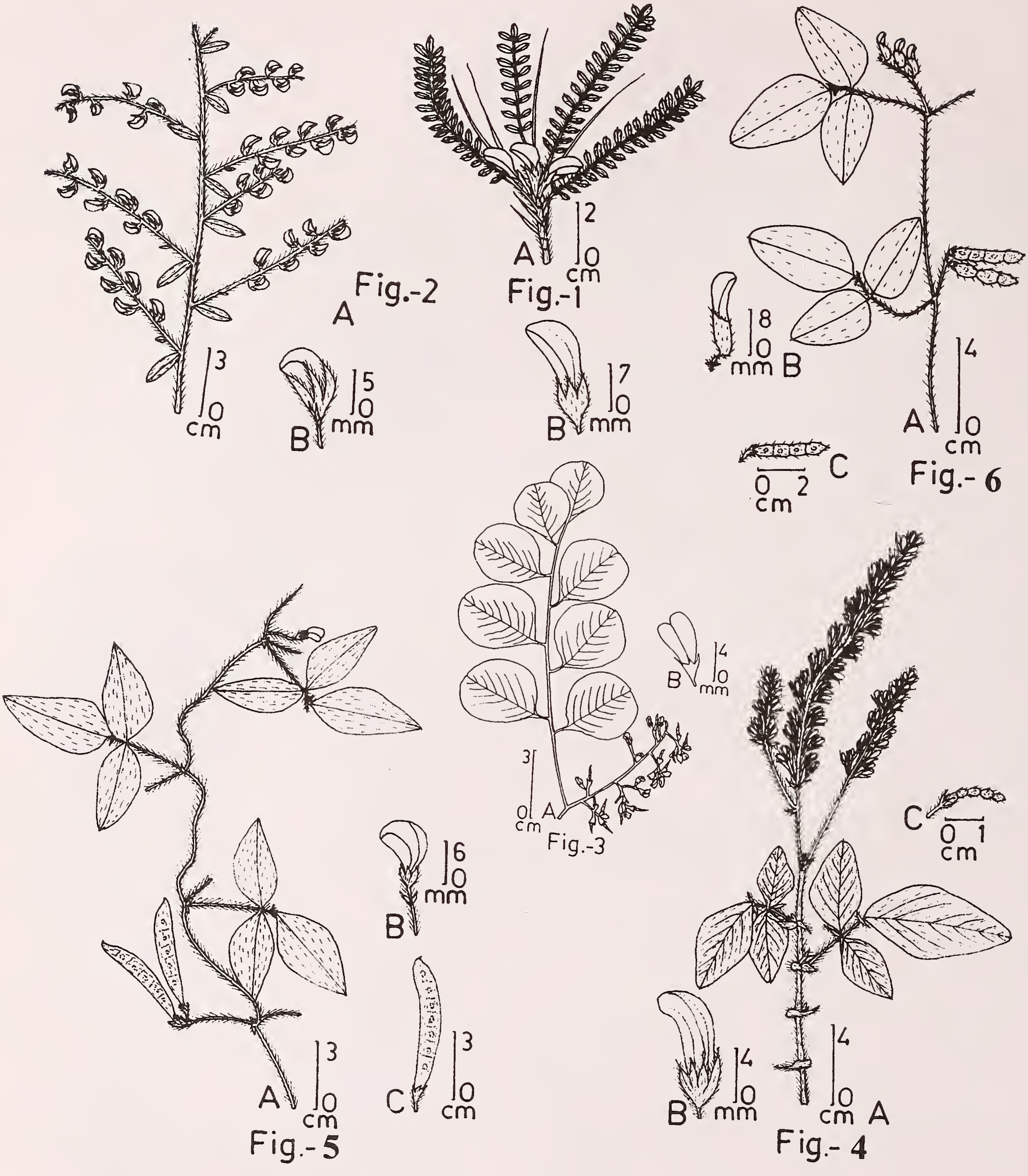
Flowering and fruiting: November-January.

Distribution: Khankara, Pauri Garhwal, 750 m a.s.l.

Ecology: A limited number of plants found in dry localities on slopes as well as in open fields, along with *Carissa opaca, Mimosa himalayana, Rhus parviflora,* and *Grewia optiva.*

Specimen examined: L.R.D., GUH-12,285.

Notes: This is a native of tropical America and


A
Fig.-2
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0
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Fig.-3
A
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cm
Fig.-5
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cm
C
0 1
cm
B
4
0
mm
4
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cm A
Fig.- 4

Fig. 1 A-B. *Astragalus cashmirensis* Bunge: A - Flowering branch; B - Flower.
Fig. 2 A-B. *Crotalaria burhia* Buch.-Ham.: A - Flowering branch; B - Flower.
Fig. 3 A-B. *Dalbergia latifolia* Roxb.: A - Floewring brarnch; B - Flower.
Fig. 4 A-C. *Desmodium tortuosum* (Swartz.) DC.: A - Flowering branch; B - Flower; C - Pod.
Fig. 5 A-C. *Dolichos tenuicaulis* (Baker) Craib: A - Flowering and fruiting branch; B - Flower; C - Pod.
Fig. 6 A-C. *Dumasia villosa* DC. var. *leiocarpa* (Benth.) Baker: A - Flowering and fruiting branch; B - Flower; C - Pod.

it is in the process of naturalization in India. Sanjappa (1992) had mentioned that it is naturalised in Karnataka, Gujarat, and Uttar Pradesh. Babu (1977) recorded it from Sahasradhara, Dehradun. However, it is the first report of its occurrence in inner Garhwal indicating its naturalization to this part of the Himalayas.

Dolichos tenuicaulis (Baker) Craib, Contr. Fl. Siam. Dicot. 66: 1912 in nota & Fl. Siam. Enum. 1: 460. 1928; Sanjappa, Leg. Ind. 167. 1992. (Fig. 5, A - C).

Flowering and fruiting: August-October.

Distribution: Towards Chelusain, Pauri Garhwal, 1600 m a. s. l.

Ecology: Rare. A few plant specimens were collected in dry localities, on slopes along dry streams, and associated with the *Berberis* sp.

Specimen examined: L.R.D., GUH-12,331.

Notes: Recently Sanjappa (1992) noted its occurrence from Sikkim, Meghalaya, Orissa, Nepal, Bhutan, Burma, and China. This species has not been collected earlier in this part of the Himalayas. Hence it is a new record for Garhwal as well as Kumaon Himalayas.

Dumasia villosa DC., Ann. Sci. Nat. Paris, ser. 1, 4: 96. 1825. var. *leiocarpa* (Benth.) Baker in Hook. f., FBI. 2: 183. 1876; Sanjappa, Leg. Ind. 168. 1992. (Fig. 6, A - C).

Flowering and fruiting: September-December.

Distribution: Pinswar Road, Tehri Garhwal, 1800 m a.s.l.

Ecology: Rare. A few plants occur along the roadsides on walls, associated with *Eupatorium* sp., *Berberis* sp. and under the shade of trees.

Specimen examined: L.R.D., GUH-12,346.

Notes: Hooker (1876) and Sanjappa (1992) recorded its occurrence in Sikkim, Arunachal Pradesh, Nepal, Bhutan, Sri Lanka, Burma, Thailand and China. This taxon has not been collected earlier from this part of the Himalayas. This is a new record for Garhwal and Kumaon Himalayas.

ACKNOWLEDGEMENTS

We thank the authorities of Botanical Survey of India, Northern Circle, Dehra Dun (BSD) and Forest Research Institute, Dehra Dun (DD) for providing herbarium facilities. Financial assistance from Department of Environment, Govt. of India, New Delhi is also thankfully acknowledged.

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34. STOMATA ON SEED OF *BAUHINIA PURPUREA* L. (LEGUMINOSAE: CAESALPINIOIDEAE)

(*With a text-figure*)

Rugenstein and Lersten (1981, *Amer. J. Bot. 68(6):* 873-876) reported the presence of stomata on seeds of some species of *Bauhinia* based mainly on SEM observations. In *B. purpurea* L. they found that the stomata on mature seeds are deformed and partially obstructed by surrounding epidermal cells which retain guard cell appearance but during a SEM study following usual method on the testa surface pattern we found that some of the stomata on mature seeds of *B. purpurea* may also be normal in appearance (Fig. 1). Both the types of stomata are, however, recessed and lack subsidiary cells.

Mature seeds were collected in the Indian Botanic Garden. Fruiting voucher from the plant (*Bandyopadhyay* 15206) has been deposited in CAL.

ACKNOWLEDGEMENT

We are grateful to the Scientist-in-Charge,

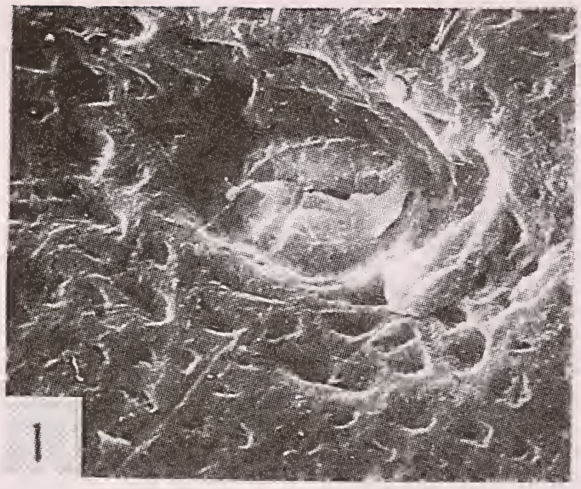

Fig. 1. Scanning electron micrograph of a stoma on mature seed of *B. purpurea,* x 650. Note its normal appearance.

R.S.I.C. for the use of Scanning Electron Microscope (PSEM 500)

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35. SEM STUDIES ON THE TESTA SURFACE PATTERN OF SOME SPECIES OF *BAUHINIA* (LEGUMINOSAE: CAESALPINIOIDEAE)

(*With a text-figure*)

Kaur *et al.* (1992) studied the testa surface pattern of some species of *Bauhinia* based on SEM observations. Their studies, however, provided little detailed information and adequate attention was not paid to the correct names. Furthermore, in the course of a SEM study on the testa surface pattern of 4 species of *Bauhinia* it was observed that our findings either did not fully agree with theirs or even differed entirely though we, too, had studied the same part of the seed (Datt, pers. comm. 1994). Thus in the present paper we have described, in detail, the testa surface pattern of 4 species, namely *Bauhinia acuminata* L., *B. malabarica* Roxb., *B. purpurea* L. and *B. semla* Wund.

Materials and Method

Mature seed samples were obtained from herbarium specimens deposited in CAL. For SEM the seeds were cleaned with cotton soaked in absolute ethanol, air dried, mounted on metallic stubs with silver paint after correctly orientating them (see Gunn 1991:16) and then gold coated in an Edward sputter-coater. Observations were made with PSEM 500 and the scanning electron micrographs were taken from the central part of the seeds.

Specimens examined: B. *acuminata*: *Sur* 15201; *B. malabarica*: *Jain* 4082; *B. purpurea*: *Bandyopadhyay* 15206; *B. semla*: *Tarafder* 18314.

Observations and Discussion

B. acuminata (Fig. 1a): The testa surface is pitted. The pits are sparsely or closely situated and vary in size. They are circular, angular or elongated.

Kaur *et al.* (1992) described the testa surface as pitted and reported of some deposition which seems to be scattered on the testa surface (see Fig. 2B in Kaur *et al.* (1992).

B. malabarica (Fig. 1b): The testa surface is regulate with scattered pits.

Kaur *et al.* (1992) described the testa surface as smooth with distinct cracks (Fig. 2A) but this could not be corroborated.

B. purpurea (Fig. 1 c-d): The testa surface is reticulate. The reticula vary in size and are angular or more or less polygonal.

B. triandra Roxb. studied by Kaur *et al.* (1992)

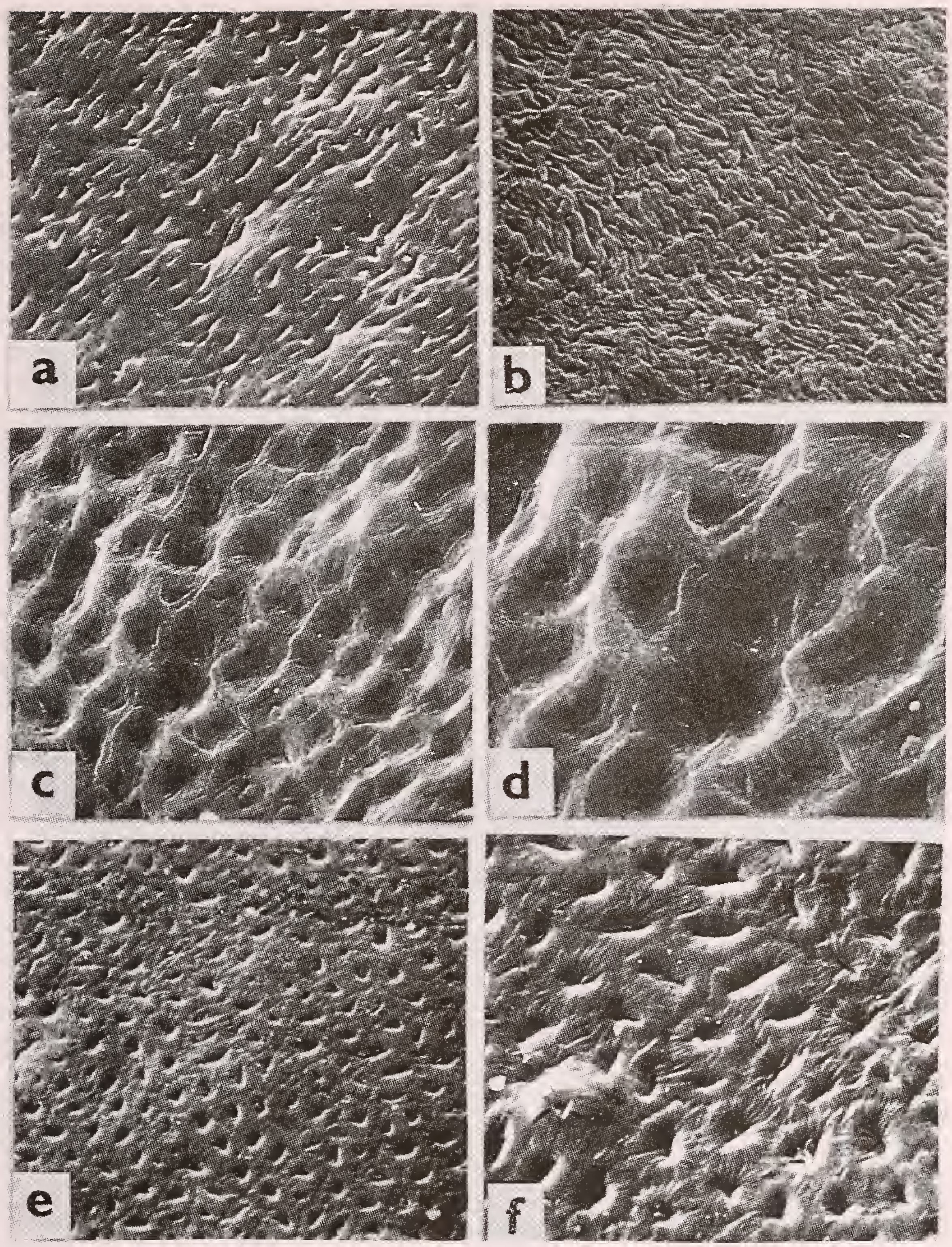

Fig. 1 . a-f. Scanning electron micrographs of testa surface pattern. a. *B. acuminata*: a, x650. b. *B. malabarica:* b, x650. c-d. *B. purpurea*: c, x650. d, x 1300. e-f. *B. semla*: e, x650. f, x 1300.

is a synonym of *B. purpurea.* They described the testa surface as pitted but this, too, could not be corroborated. However, it might be that they inadvertently studied the part near the margin of the seed where the testa surface pattern ranges from reticulate to pitted. Further, it was confirmed (Datt, pers. comm. 1994) that the scanning electron micrograph of the testa surface pattern (Fig. 2D) labelled as *B. triandra* is actually that of *B. semla.*

B. semla (Fig. 1 e-f): The testa surface is pitted. The pits are closely situated and vary in size. They are circular, angular or slightly elongated and have fine striations around them.

Kaur *et al.* (1992) overlooked *B. semla, nom. nov.* for *B. retusa* Roxb. The description of the testa surface pattern provided by them, however, corroborates with ours but the scanning electron micrograph of the testa surface pattern (Fig. 2C) labelled as *B. retusa* was likely to have been interchanged with that of *B. triandra.*

ACKNOWLEDGEMENTS

We are grateful to the Director, Botanical Survey of India for providing necessary facilities and encouragements to the Scientist-in-Charge, R.S.I.C. for the use of SEM and to Dr. Bhaskar Datt, National Botanical Research Institute, Lucknow, who on our request kindly made contact with one of the authors of the paper cited in the reference and conveyed to us the latter's comments to our queries regarding part of seed studied by them and the caption of Fig. 2D given in their paper.

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KAUR, HARBANS, R.P. SINGH, A. PAL & K. SAHAI (1992): Morphology, spermoderm pattern and anatomy of some *Bauhinia* species (Caesalpinioideae-Leguminosae). *J. Indian bot. Soc. 71(1-4)*: 135-138.

36. ON THE OCCURRENCE OF *GENTIANA INFELIX* CLARKE (GENTIANACEAE) IN GARHWAL HIMALAYAS

(*With a text-figure*)

During plant explorations in the alpine zones of Garhwal Himalayas a few plant specimens belonging to the Genus *Gentiana* were collected from Kedarnath area. After checking at the Herbaria of Forest Research Institute, Dehra Dun (DD) and B.S.I. Dehran Dun (BSD) and checking recent literature (Garg 1987, Gentianaceae of Northwest Himalaya. CSIR, New Delhi) they have been identified as *Gentiana infelix* Clarke (Gentianaceae).

This species has been considered extremely rare in India and except the syntype from Sikkim and Kumaon there is only one collection from Kinnaur, Himachal Pradesh and one from Sikkim (Garg 1987). It is interesting to note that although it is described from Kumaon on the basis of Strachey and Winterbottom's specimen it has not been collected from Kumaon and Garhwal.

In this communication the full description of the species together with illustrations has been provided to facilitate further collections and easy identification of the species from North-West Himalayas.

The voucher specimens are deposited and maintained at Herbarium H.N.B. Garhwal University, Srinagar Garhwal, India (GUH).

Gentiana infelix Clarke in Hook. f. Fl. Brit. India 4:111.1883; Kusn. in Acta Horti Petrop. 15(3): 359.1904; Nair, Fl. Bashahr Himal. 186.1977.

Perennial, subglabrous, woody based herbs, branching from the base. Branches many from rootstock, prostrate or ascending, 1.0-2.5 cm long, woody in lower half. Leaves opposite, dry on lower half portion of stem, ovate-oblong, sessile, subobtuse-acute, imbricate, 1-3 x 2-6 mm, one nerved, leaves of uppermost pair pointing upward; leaf pair forming tubular sheath up to 1 mm long, imbricate in sterile branches. Flowers pedicellate, solitary - terminal, inflexed, violet, 8-11 mm long,

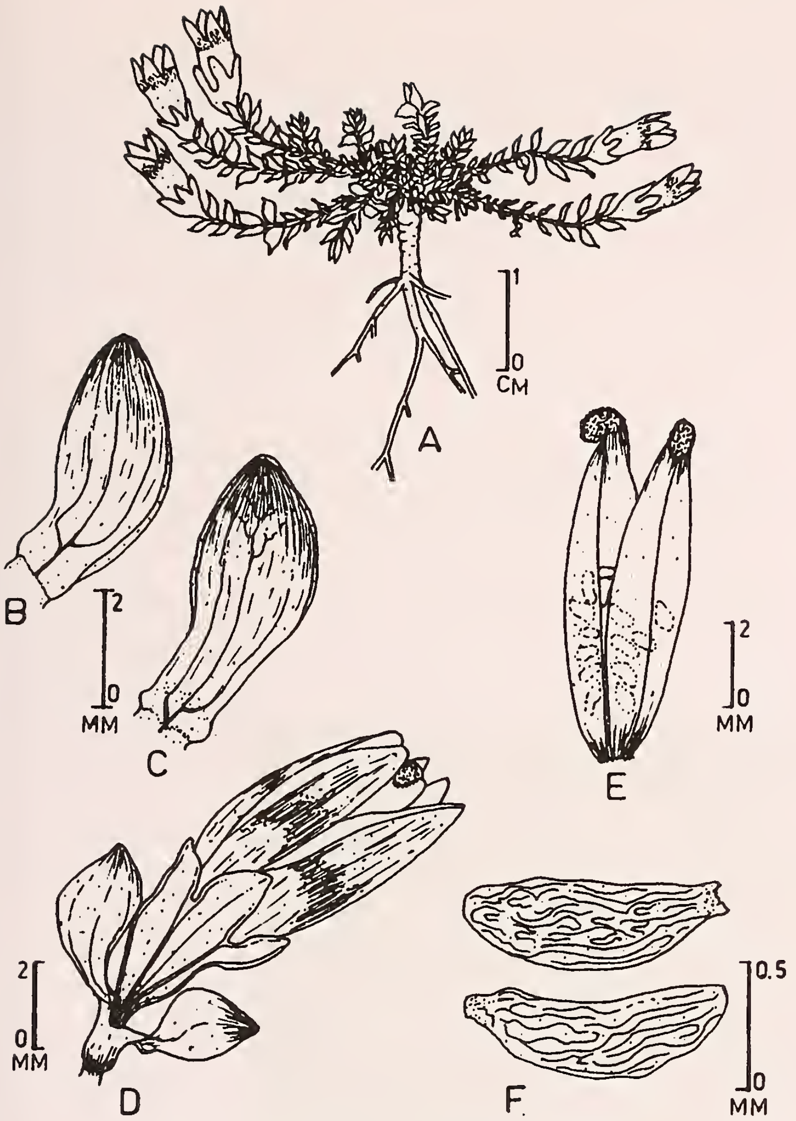

Fig. 1, A-F. *Gentiana infelix* Clarke
A. A flowering plant; B. Uppermost leaf;
C. Middle leaf; D. Flower; E. Capsule; F. Seeds.

usually tetramerous, or pentamerous. Pedicel 1-4 mm long, narrowly alate on upper side. Calyx tubular, 4-5 mm long, tube 2-3 mm, lobes 4 (5), ovate with rounded tips, infundibuliform, lobe 2-2.5 x 1.5-1.75 mm, pubescent on outer side specially on nerves. Corolla tubular, 6-10 mm long, subinfundibuli form to campanulate, tube 4-7 mm long, lobes 4 or 5, ovate, subobtuse to obtuse, 2-3 mm long, plicae integral, up to 0.75 mm long, triangular, entire, acute. Stamens as many as corolla lobes, attached to middle of corolla tube; filaments 3-4 mm long, anthers ovate-oblong, 0.5-0.75 mm, one nerved. Ovary elliptic-oblong, sessile, 4-6 mm long, 2-3 mm broad, laterally compressed; style 0, stigma of two diverging papilose lobes. Capsule sessile, included in the persistent corolla, oblong-elliptic, 6-8.5 mm long, 2-3 mm broad, with persisting stigma lobes. Seeds oblong-elliptic, *c.* 1 mm long, glabrous, pale green to brown, many in a capsule (Fig. 1A-F).

Flowering and fruiting: August-October.

Distribution: Himachal Pradesh (Kinnaur), Kumaon (Brij Kang Pass); Sikkim (Nathula) and recently from Garhwal (Kedarnath) by us. The species is also distributed in Tibet, China and Nepal.

In Kedarnath area the species grows on exposed grassy slopes along with *Gentiana tubiflora* and other species.

Specimens Examined: Sikkim, Nathula, 4270 m, 12.8.1945, *Bor's collect.* 558 (DD). Nepal, Lumbe Sumba Himal, 4875 m', 18.7.1956, *J.D.A. Stainton,* 124658 (DD). Himachal Pradesh, Kinnaur, Chinni, 2775 m, 3.5.1962, *Nair,* 22369 (BSD). Garhwal, Kedarnath area, 4600 m, Sept. 1993, *D.S. Rawat* and *A.K. Badoni*, 19904 (GUH); Kedarnath area, 4500 m, 10.8.1994, *D.S. Rawat,* 19987 (GUH).

The collection of this species from Garhwal is of considerable interest as it has been collected after about 150 years from the region of Kumaon and Garhwal and except the type specimens only two collections are known from India.

ACKNOWLEDGEMENTS

We thank the authorities of the Forest Research Institute and the Botanical Survey of India, Dehra Dun for providing herbarium and library facilities. The Senior author (DSR) is thankful to UGC, New Delhi for granting a fellowship for research work.

April 8, 1995

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37. SEM STUDIES ON THE TESTA SURFACE PATTERN OF TWO SPECIES OF *BAUHINIA* (LEGUMINOSAE: CAESALPINIOIDEAE)

(*With a text-figure*)

SEM studies on the testa surface pattern of some species of *Bauhinia* have been undertaken by Trivedi *et al.* (1980), Gunn (1991), Kaur *et al.* (1992), Bandyopadhyay *et al.* (1993). In the present paper we have described the testa surface pattern of two species, namely *Bauhinia diphylla* Symes and *B. vahlii* Wight & Arn. that have not been studied earlier.

MATERIALS AND METHOD

Mature seed samples were obtained from herbarium specimens deposited in CAL. For SEM the seeds were cleaned with cotton soaked in absolute ethanol, air dried, mounted on metallic stubs with silver paint after correctly orientating them (see Gunn 1991: 16) and then gold coated in an Edward sputter-coater. Observations were made with PSEM 500 or PSEM 515 and the scanning electron micrographs were taken from the central part of the seeds.

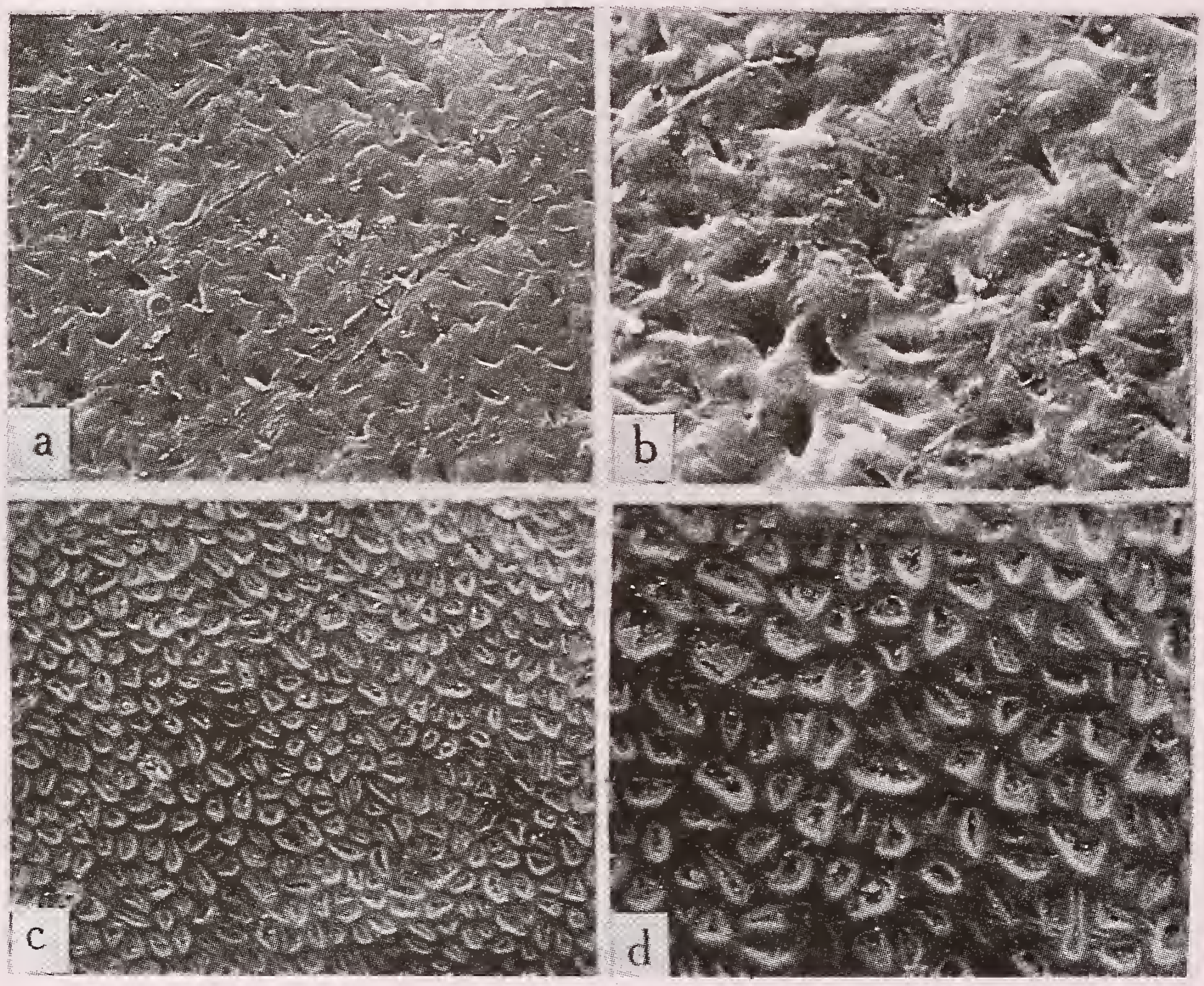

Fig. 1, a-d. Scanning electron micrographs of testa surface pattern.
a-b. *B. diphylla:* a, x 650; b, x 1300. c-d. *B. vahlii*; c, x 3 00; d, x 600.

Specimens examined: *B. diphylla*: *Kurz* 2577; *B. vahlii*: *Rao* 23296.

OBSERVATIONS

B. diphylla (Fig. 1 a-b): The testa surface is pitted. The pits are closely situated and vary in size. They are elongated, slit-like or angular, sometimes more or less circular and have fine striations around them.

B. vahlii (Fig. 1 c-d): The testa surface is pitted. The pits are closely situated and vary in size but are comparatively larger than those of *B. diphylla.* They are angular to elongated, sometimes more or less circular but rarely slit-like.

ACKNOWLEDGEMENTS

We are grateful to the Director, Botanical Survey of India for providing necessary facilities and encouragement, to the Scientist-in-Charge, R.S.I.C. and Dr. G.V.S. Murthy, Botanical Survey of India for the use of SEM.

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Madras. 600 093.

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38. *KAEMPFERIA SIPHONANTHA* KING EX BAKER (ZINGIBERACEAE) IN THE ANDAMAN ISLANDS

(*With a text-figure*)

The genus *Kaempferia* L. is represented by eight species and one variety in India (Karthikeyan 1989) of which *K. siphonantha* King ex Baker is endemic to the Andaman group of islands (Vasudeva Rao 1986). Collected by King's collec-tor and later described by Baker in Flora British India (Hooker 1890). *K. siphonantha* King ex Baker is the only representative of the genus in the islands.

While on survey in Kalpong reserve forests in North Andamans, the first author collected specimens of the species and confirmed its identification after consulting CNH at Calcutta and scrutiny of literature. The present collection of this rare, vulnerable, herbaceous, endemic plant after a gap of more than a century indicates that the species has not become extinct yet but is on the verge of extinction as the natural habitats have already deteriorated or are under destruction in view of the proposed first ever hydroelectric project in the collection site.

In the present communication, a description of the species accompanied by an illustration (Fig. 1) are given in order to facilitate easy identification and conservation in the field or by *ex situ* conservation and propagation.

Kaempferia siphonantha King apud Baker in Hook. f., Fl. Brit. Ind. 6: 222. 1890.

Herbaceous annuals up to 20 cm tall, no leafy stem. Root stock tuberous with slender root fibres. Leaves 3-4 in a tuft, leafblade up to 8-9 x 2-2.5 cm, oblong, acute, minutely crenate, glabrous, membranous, base unequal sided, sides rounded, oblique; petiole 8-9 cm long. Spike as long

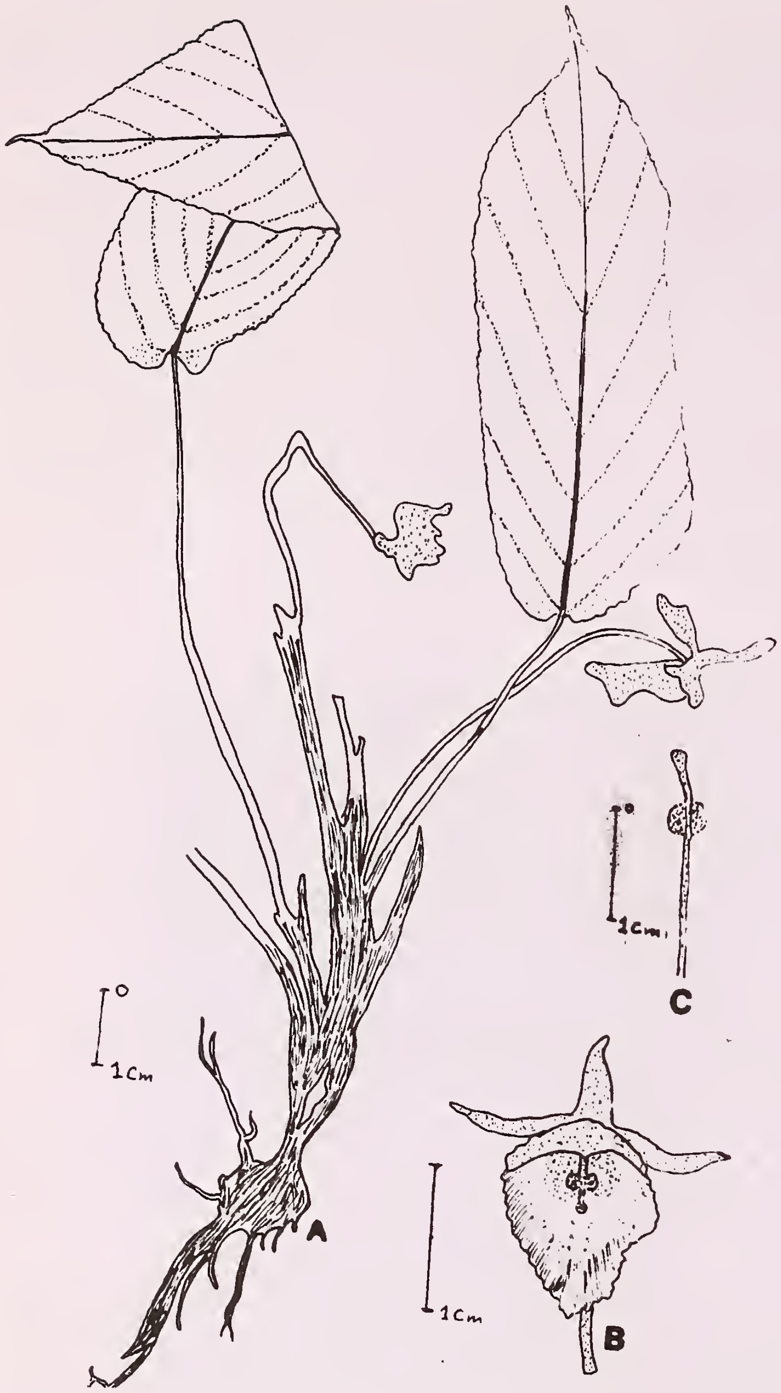

Fig. 1. A-C: *Kaempferia siphonantha* King ex Baker
A. Habit; B. Flower; C. Long style and turbinate stigma with crested anthers on either side of the style.

as or longer than petiole; flowers solitary on a slender spike. Corolla tube much exerted from bract; lobes *c.* 1.2 cm long, oblong, lanceolate, greenish; lip white, broad, bifid or not, distal end and median tinged with purple blotches. Stamens one, filaments short; anthers on either side of style; connective crested. Ovary 3-celled, style long, filiform; stigma turbinate. Fruits not seen.

Specimens examined: Kalpong hill forest slopes between Diglipur and Kalighat (near forest camp), North Andaman, 3.9.1988, *P.S.N. Rao*, 13250; Inland evergreen forests of Betapur, Middle Andaman, 23.7.1974, *N. Bhargava*, 1850 (unidentified).

Note: The species is endangered due to restricted distribution with limited populations, rapid destruction of natural habitats and deforestation/ecological disturbance in its specific niches.

ACKNOWLEDGEMENT

We are grateful to Dr. P.K. Hajra, Director, Botanical Survey of India, Calcutta for encouragement and facilities.

April 8, 1995

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39. ON THE OCCURRENCE OF *DIMERIA KANJIRAPALLIANA* K.C. JACOB (POACEAE) IN ANDHRA PRADESH

(*With a text-figure*)

During the floristic survey of grasses of Andhra Pradesh, we collected a grass from Medak and East Godavari districts, which was identified as *Dimeria kanjirapalliana* K.C. Jacob and constitutes

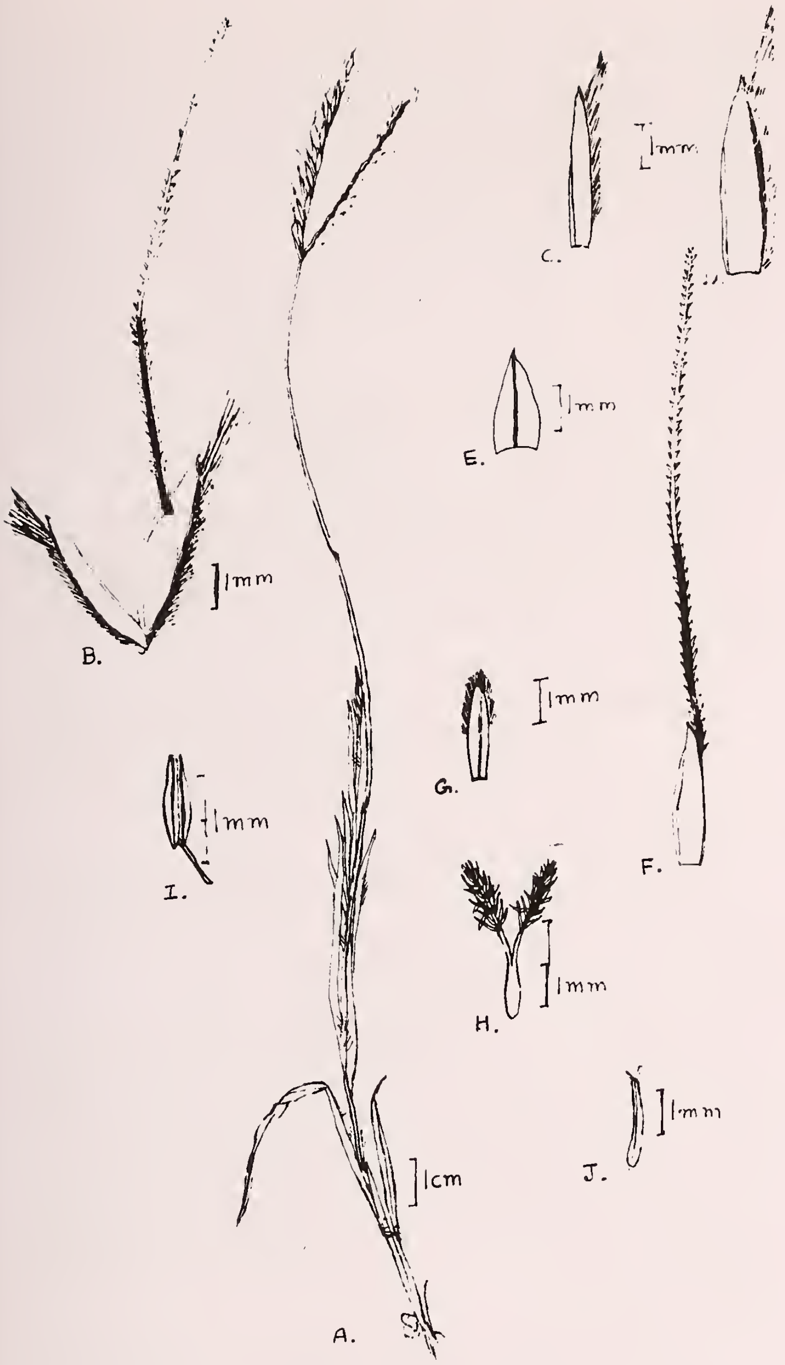

Fig. 1, A-J: *Dimeria kanjirapalliana* K.C. Jacob
A. Habit; B. Spikelet; C. Lower glume;
D. Upper glume; E. Lower lemma; F. Upper lemma;
G. Palea; H.Pistil; I. Stamen; J. Caryopsis.

a new distributional record for Andhra Pradesh. It was earlier reported from Idukki, Quilon and Calicut of Kerala (Sreekumar and Nair 1991, Flora of Kerala-grasses. BSI, Calcutta). A detailed description and illustration is given below for easy location of this grass.

Dimeria kanjirapalliana K.C. Jacob in J. Bombay nat. Hist. Soc. 47: 48. 1947; Manilal & Sivaraj, Fl. Calicut 231. 1982. (Fig. 1).

An annual, tufted grass; culms up to 25 cm tall, erect, occasionally branched near the base; nodes sparsely bearded or glabrous. Leaf sheaths 3-4 cm long, glabrous, keeled; ligule membranous, ovate, acute; blades linear, 2-6 x 0.2-0.4 cm, rounded at base, bulbous based hairs along the margins, acuminate at apex. Spikes 2, 3-8 cm long, divaricate; rachis flat, zig-zag, margins sparsely ciliate, narrowly winged. Spikelets sessile, 4.5 mm, oblong-lanceolate; callus villous. Lower glume linear-lanceolate, 2.5 mm, chartaceous, sparsely hairy at the apex, acuminate; upper glume lanceolate, 3 mm, chartaceous, hairy at the apex, margins hyaline, lower lemma hyaline, 2 mm, oblong, 1-nerved; upper lemma hyaline, 3 mm (excluding the awn), bifid, awned at the sinus, awn 1 cm long. Stamens 2, anthers oblong, 0.9 mm, filament 0.5 mm; pistil 1.75 mm. Caryopsis linear, 1.85 x 0.1 mm.

Occasional on humus soil and rocky areas of Medak and East Godavari districts. Associated with *Drosera* species.

Fl. & Fr.: October - January.

Specimens examined: Pocharam (Medak District, Andhra Pradesh), *T. Pullaiah & M.S. Gayathri* 12024 (SKU).

January 5, 1995

M.S. GAYATHRI
T. PULLAIAH
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Anantapur 515 003, A.P.

40. TWO NEW RECORDS OF ORCHIDS FOR ANDAMAN ISLANDS

During a recent plant exploration trip to some remote areas of the Ritchie's Archipelago (Middle & South Andaman), we came across two interesting and rare orchids, which on critical examination, were identified as *Acriopsis indica* Wt. and *Kingidium deliciosum* (Reichb. f.) Sweet. Both of them were collected from a Mangrove swamp and found growing on *Heritiera littoralis* Dryand. as epiphytes.

In India, the former is reported so far only from North-East India (South Tripura) and the latter from peninsular India & North-Western Himalayas. The occurrence of these two orchids as epiphytes in the Mangrove swamps of Middle Andaman forms new distributional records for Andaman islands. Hence the present collection and notes of these two species of orchids would be of much interest in highlighting the extended range of distribution in new regions of India. A detailed description for each plant species has been provided to facilitate easy identification and further study. The specimens have been deposited in the herbarium of Andaman and Nicobar circle, Botanical Survey of India, Port Blair (PBL).

The genus *Acriopsis* Reinw. ex Blume consists of 12 species, distributed in Indo-China, W. Malaysia, New Guinea, Solomon Island, etc., (Willis 1973) of which 2 species occur in India and one in Andaman & Nicobar islands. Similarly, the genus *Kingidium* P. Hunt holds over 5 species in W. Malaysia and India, of which 3 species occur in India (Karthikeyan *et al.* 1989) and one in Andaman & Nicobar islands. The present report on both these plants form new generic records for the Bay islands.

Acriopsis indica Wt., Ic. t. 1748. 1852; Hook. f., Fl. Brit. India 6: 79. 1890; C.L. Malhotra & Deori in Bull. Bot. Surv. India 15: 153, t. 1-8. 1973; Seidenf. In Opera Bot. 72: 103. 1983.

Epiphytes on *Heritiera littoralis* Dryand. Pseudobulbs 0.5-2.0 cm long, oblong or ovoid, densely tufted, covered with scarious fibres, annual rings pinkish-brown. Roots white, branched, spongy, spreading copiously. Leaves 2.0-12.5 x 0.3-0.8 cm, narrowly linear, acute at apex, convolute at base. Inflorescence a panicle, dark green, lateral, erect from the base of the pseudobulb, laxly flowered, 8-28 cm long (including scape); scape stout, branched, 8.5-12.5 cm long. Flowers small, greenish-yellow, suberect, pedicelled. Pedicellate ovary *c.* 7 mm long. Bracts small, ovate, acute. Sepals and petals faintly blotched with purple, spathulately obovate, gland dotted; dorsal sepals arched, *c.* 4 x 2 mm, 5-nerved; laterals connate, incurved, *c.* 4 x 2 mm. Petals equal, *c.* 5.0 x 2.5 mm, 3-nerved. Lip *c* 4.5 x 2.5 mm, constricted above the middle, obtuse, adnate to the basal half of the column by short claw forming a narrow tube, 3-nerved, blade white with a few violet spots and two erect lamellae on the disc about the middle, gland-dotted, margins undulate; column erect with two slender decurved processes on either side of the stigma, 4 mm high; rostellum beaked; anther oblong; pollina 2, with longitudinal furrow on a common slender stipe, with minute gland; ovary pedicelled, pedicel *c.* 5 mm, capsule oblong, 10 mm long, 6 ridged, suberect, smooth, green.

Fl. & Fr.: September-November.

Distribition: NE. India (Assam), Burma, Cambodia, Vietnam, Malaya, Java, Borneo, Celebes, Philippines.

Ecology: Rare, in mangrove forests, found growing on *Heritiera* sp. in association with other epiphytic herbs, namely *Dischidia nummularia* R. Br., *Bulbophyllum* sp., etc.

Specimens examined: Middle Andaman, Parlo Island (Near Long Island), 25.10.1994, *Sreekumar* et *L.N. Ray*, 16484.

Kingidium deliciosum (Reichb. f.) Sweet in Amer. Orch. Soc. Bull. 39: 1095. 1970; Seidenfaden in Orch. Pen. Malaysia & Singh. 657. 1992. *Phalaenopsis deliciosa* Reichb. f. in Bonplandia 2: 93. 1854. *Doritis wightii* (Reichb. f.) Benth. in Benth. & Hook. f. Gen. Pl. 3: 575. 1883; Hook, f., Fl. Brit. India 6: 32.1890.

Phalaenopsis wightii Reichb. f. in Bot. Zeit. 214. 1862.

Kingiella decumbens (Griff.) Rolfe in Orchid. Rev. 25: 197. 1917; Fischer in Gamble, Fl. Pres. Madras 3: 1006. 1957. *Kingidium decumbens* (Griff.) Hunt in Kew Bull. 24: 97. 1970; Henry *et al.* in Fl. Tamil Nadu (Anal.) 3: 16. 1989.

Epiphytes. Stem 1-2 cm long. Leaves 2-3, subcoriaceous, pendulous, sessile, 3-15 x 2.5 - 5.5 cm, oblong-oblanceolate, spathulate or elliptic, undulate at margins, blunt, minutely or obliquely notched at apex. Inflorescence pendulous, from the stem beneath the leaves, 7-13 cm long, slender below, slightly thickened towards the tip, sometimes with a short branch. Flowers 1-2 cm across, white, marked with violet and purple. Pedicels 5-10 mm long. Bracts ovate, acute, minute. Sepals unequal, 10-15 x 5-6 mm, the dorsal oblong, obtuse, blunt; lateral sepals shorter but broader, spathulate. Petals equal to the lateral sepals, oblong, blunt. Lip with a short wide spur, white with purple markings, 3-lobed; lateral lobes broader than long, apex rounded to truncate, mid-lobe obcordate with a broad emarginate apex. Pollinia 4, unequal in size. Immature capsules *c.* 5 x 0.4 cm, linear, ridged.

Fl. & Fr.: September-October.

Distribution: Peninsular India, North-Western Himalayas; Sri Lanka; Malaysia, China, Philippines, Java & Thailand.

Ecology: Rare, in shady mangrove forests, as epiphyte on tree trunk.

Specimens examined: Middle Andaman, North Passage Island, 24.10.1994, *Sreekumar* et *L.N. Ray* 16473.

ACKNOWLEDGEMENTS

We are grateful to Dr. Gunnar Seidenfaden for kindly confirming the identity of the plants and Dr. P.K. Hajra, Director, Botanical Survey of India, Calcutta for encouragement.

June 12, 1995

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BOMBAY NATURAL HISTORY SOCIETY

Hornbill House, S.B. Singh Road, Bombay 400 023.

110th ANNUAL REPORT AND ACCOUNTS
FOR THE YEAR 1ST APRIL 1993 TO 31 MARCH 1994
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Vice Presidents Mrs. D.S. Variava, Dr Pratap Saraiya,
Mr. Divyabhanusinh Chavda
Hon. Secretary Mr. J.C. Daniel (up to 1993)
Dr. Ashok Bhagwat (from January 1994)
Hon. Treasurer Mr. Sunil Zaveri
Director Dr. Jay Samant

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Dr. B.F. Chhapgar, Mr. Nandan Maluste, Mr. Shrikant Pol,
Dr. A.M. Bhagwat, Mr. T.V. Sowrirajan, Mr. Yogi Andley,
The Secretary, Ministry of Environment & Forests, Govt. of India,
The Director of Archaeology & Museums, Govt. of Maharashtra.

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The Secretary, Ministry of Environment & Forests, Govt. of India,
The Director of Archaeology & Museums, Govt. of Maharashtra.

SPECIAL INVITEES

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ADVISORY COMMITTEE MEMBERS

Dr. D.K. Lahiri Choudhury, Prof. Raghavendra Gadagkar, Dr. Anil Gore, Prof. K.C. Malhotra,
Dr. A.N.D. Nanavati, Mr. Ulhas Rane, Dr. E.G. Silas, Lt. Gen. Baljit Singh, AVSM, VSM,
Mr. Samar Singh, Mr. Romulus Whitaker.

AUDITORS

M/s. Habib & Company, Chartered Accountants, Bombay.

BOMBAY NATURAL HISTORY SOCIETY ANNUAL REPORT FOR THE YEAR ENDED 31ST MARCH, 1994

COLLECTIONS

Curator: N. Chaturvedi

Mammal: *Scientist — Mr. Manoj Muni*

Work of computerisation of the card-index data was continued. In all 15500 records completed.

For preparation of status report on the mammal collection condition of 8000 specimens was checked. Assisted Ms. Mery Willis from the Washington University for her study on the mammals.

37 bat specimens were received from the Harrison Zoological Museum as half of the total animals collected during the Harisson Zoological Museum-BNHS joint mammal survey in 1992.

87 specimens loaned to Dr. Charles Woods of the Florida Museum of Natural History, USA were received back.

A scientific paper was presented in the First Indian National Bat Research Conference held at Nagpur.

Visited Harrison Zoological Museum in UK for training on taxonomy of bats.

Participated in the Indo-British Course on the Biomonitoring of Forests conducted by the Wildlife Institute of India, Dehradun.

A paper on "A new record of Leaf-nosed bat *Hipposideros lankadiva* from Sangameshwar, Maharashtra" was prepared and submitted for the publication in the JBNHS.

Paper "Resurvey of Indian Chiroptera" was prepared and submitted for the publication in the proceedings of the Indo-British course on the Biomonitoring of the Forests.

Molluscs

23 shell specimens sent in by Dr. M. Kirloskar were identified.

Bird: *Scientist — Dr. (Mrs) S. Unnithan*

During the year specimens of Flowerpeckers and Sunbirds were worked out, measured, catalogued as species and sub-species. A Wren-Babbler skin (part of it) collected from Arunachal Pradesh, was identified as Mishmi-Wren-Babbler and added to the collection. 32 specimens of *Anthus* collected by Dr. Sálim Ali during the years 1966, 1967 and 1968 and left unidentified, were studied, identified and added to the collection after registering.

Training was given to Ms. Malvika Chaudhuri of Bareily College in collection and identification of bird.

Part 37 of the catalogue dealing with Sunbirds and Flowerpeckers was completed and ready for publication. Since the previous part, (*Anthus*) is still being worked out, part 37 is withheld.

Herpetology: *Scientist — Mr. Aloysius G. Sekar*

1116 specimens of 74 species of amphibians, tortoises and snakes were checked for their condition.

Specimens of caecilians were referred to by Dr. R.S. Pillai, Emeritus Scientist from ZSI southern zone. Ms. Gitanjali Tiwari referred the snake collection for identification.

1900 collection data of reptiles have been entered in the computer.

Specimens of lizards sent by Mr. L. Subraya were identified as of *Hemidactylus brooki, H. leschenaulti* and *H. frenatus.* Slides of lizard brought by Mr. Ramana Athreya were identified. Assistance was given to members and visitors in studying collection.

(a) A project was undertaken to study the community structure of amphibian fauna in tropical monsoon forest. The field work was done in the Sanjay Gandhi National Park, Borivli. (b) Tadpoles of common toad were reared to find out the period of metamorphosis.

Participated in the Indo-British Biological monitoring course conducted at WII, Dehradun.

(a) A paper entitled 'On the morphometry, advertisement call and habitat of the bush frog

Philautus leucorhynus, and a note on the 'Range extension of the spotted forest Gecko, *Cyrtodactylus c. collegalensis'* were accepted for publishing in the Journal of BNHS. (b) Another paper on 'the community ecology of amphibians of Sanjay Gandhi National Park' was submitted for the proceedings of the seminar on Biological monitoring course conducted at WII.

Entomology: *Scientist — Mr. N. Chaturvedi*

100 Specimens of Butterflies and other insects received from Grassland Ecology Project were identified. 40 specimens of Moths and butterflies received from Dept. of Life Science, Sophia College were identified. Information on collection and preservation was given to M.Sc. (Entomology) students of college from Ulhas Nagar. Insects visiting ground lilies of species *Chlorophytum* and *Scilla* were collected. Plant insect interaction was studied in relation to plant *Ceropegia oculata.*

Publications

Notes on 'Some observation on Lifecycle of *Delias eucharis, Trichodesma amplexicaulis'*, 'an adult male attractant of Danaid butterfly', and a note on 'Rose Ringed Parakeet' were published.

Herbarium: *Scientist — Ms Neelam Patil*

136 specimens of plants brought by the Scientist from Grassland Ecology project were identified and report was submitted. 51 specimens received from Life sciences dept., Sophia College were identified. Besides these specimens photographs brought by members and staff were identified. Assistance was given to members and staff in identification of plant specimens and referring herbarium.

The bibliography of the papers and short notes published in JBNHS in the field of Botany from 1976 onwards was prepared (earlier ones has been prepared by BSI)

CONSERVATION EDUCATION PROJECT

Project Co-ordinator: Dr. Jay Samant
Project Field Manager: Mr. A. Karandikar

Duration: September 1993 — August 1996

The Conservation Education Project commenced in September 1993. The foundation stone of the Centre was laid at the BNHS land at Goregaon (East) by the Governor of Maharashtra Shri P. C. Alexander on 21st September 1993.

A series of workshops were conducted which were attended by Mr David Elcome of RSPB from UK, the staff members and others involved in the project. During the first such workshop Mr Ken Smith from RSPB was also present. Project Schedule was worked out and project is progressing accordingly.

Prof. K. C. Malhotra from Indian Statistical Institute, Calcutta, who is also on the Advisory Board of BNHS conducted three days workshop with project staff and consultants and gave valuable information on various aspects of the project. Similarly outside statistical help is being sought for data analysis in the project.

The Baseline Survey was completed in the February 1994 in three project areas, i.e. i) Borivli, Bombay ii) Bharatpur, Rajasthan and iii) Gudalur, Andhra Pradesh. This provides socio-economic data of the population and their level of awareness and attitude towards wildlife, forests and its management.

The Experimental Phase was initiated in March 1994 during which different media would be tried with various target groups for different issues. School based and village level programmes would be conducted in this phase at all the three field stations. The project team and the concept are now well accepted by people, officials, NGOs and other groups in the project areas. This contributes towards promotion of BNHS in addition to spreading the message of nature conservation.

Tender for constructing the Conservation Education Centre at BNHS land, Gorgoan (East), was approved in May 1994. Work on site commenced immediately.

Equipment necessary for the field mobile units has been procured.

NGO are being contacted for networking towards conservation education. A meeting of NGOs working locally at Mudumalai Wildlife Sanctuary was arranged and more are planned. BNHS initiative in networking is well appreciated by these NGOs and these have shown interest in taking part in the project activities.

LIBRARY

Librarian - Mr. Isaac Kehimkar

Asst. Librarian - Ms Shubhangi Puradkar

An exhibition of rare books on Indian wild life organised at Hornbill House was a big success. Media all over the country hailed it and gave it a wide coverage beyond all expectations. The precious books in our possession were kept in glass cabinets, kindly loaned to us by the Prince of Wales Museum and the Asiatic Society. As aimed, well deserving focus was drawn on activities of BNHS. Enrollment of new members as well as sale of products at the products counter were maximum during this period. The exhibition also gave us an opportunity to check our books which were found in satisfactory condition. Rev. Father Correa, Director of Heras Institute, an authority on rare books was pleased with the condition and richness of BNHS collection and the manner in which the books were exhibited.

Mr J.J. Bhabha, while inaugurating the exhibition donated a handsome sum of Rs.1,00,000/- from Sir Dorabji Tata Trust and promised further flow of help in future.

Mr. Gokhale who had also visited this exhibition gave a donation of Rs.1,00,000/- from Govind Dattatraya Gokhale Charitable Trust towards preservation of books in the library and for educational activities of the Society for the year 1993-94.

Since our Journals are available on microfiche also, Miroficbe reader-cum-printer was installed during this year. This facility is available to outsiders also. This was possible due to kind donation received from M/s. Venkateshwara Hatcheries.

The Asst. Librarian joined the Society from December 15, 1993.

At the end of March 1994, the library collection stands 12,208 books (including bound volumes of periodicals). In 1993-94, 328 books were added to the library. 16 books were received from the publishers for the purpose of publishing reviews in our Journal and 260 as complimentary copies from authors, individuals, etc 52 books were purchased for the library and various projects.

MEMBERSHIP

Membership Officer: Ms. Caroline Vincent

Type of membership	Year		
	1991	1992	1993-94
Ordinary (Indian)	1584	1527	1663
Student	416	403	480
Life (Indian)	1261	1305	1345
Corporate	75	32	54
Compound Corporate	113	111	111
Family	46	57	discont.
Ordinary (Foreign)	54	15	24
Life (Foreign)	213	211	211

The Membership particularly of Ordinary Members has shown a slight rise to 1663 in 1993-94. An attempt to increase membership has been started with some effect. In this regard, we have appointed a Membership Officer who will undertake, special membership drives in collaboration with other BNHS departments, like Nature Education & Products.

We shall be happy to receive any suggestion from our members and well wishers.

NATURE EDUCATION

Nature Education Officer: Mrs Shailaja Grubh / Mr Deepak Apte

Nature education is imparted through field trips, exhibitions, visit to Museum, Aquarium, Zoo, etc. Nature orientation workshop for teachers, competitions like painting, essay, quiz on wildlife, film shows, slide shows and so on.

The field trips are mainly arranged for school students between 8th and 12th std. A group of 30 students is taken for excursion, in which various aspects of nature like birds, trees, insects, ecosystems, etc., are taught.

This year a total of 2200 students participated in various activities. Field outings were arranged at Karnala, S.G.National Park and Tungareshwar. Students were taken to Juhu seashore to study marine life. Each outing was followed by a group discussion. Visits were also arranged at Bombay zoo.

Talks/slide shows/film shows were arranged at various schools.

The Nature Education Organiser went on long leave followed by resignation. The activities were conducted with assistance of Herbarium-collection staff. The new Education Officer (Mr. Deepak Apte) took charge in January 1994.

NATURAL HISTORY STUDIES

The following activities were undertaken with financial assistance from the Natural History Studies Funds.

"A study of host preference and avian frugivory of strangler figs in a tropical evergreen forest in the Southern Western Ghats, India" by Ms. Vidya Athreya.

A project "Survey of Migratory Birds — specifically Flamingoes and Curlews" has undertaken by Mr. Chandrashekharan and Mr. Mangesh Chavan.

A study on "Ecology of Amphibians of Northern Western Ghats" with special reference to the Sanjay Gandhi National Park, Borivli, Bombay by Mr. A.G. Sekar.

PROGRAMME

Programme Officer: Mr. P. B. Shekar

Annual Nature camp: Annual Nature camps are enjoyed by our members from all over India. This year the annual Nature camps were arranged at Chopta (near Tungnath) in Garhwal Himalayas, Kanha National Park in Madhya Pradesh and Dudhwa National Park in terai area of Uttar Pradesh.

Overnight Nature Camps: Overnight Nature camps were arranged at various places of Natural History interest not only around Bombay but also all over Maharashtra. The participants of Nature camps at Bhimashankar and Marleshwar got first hand information on Sacred Groves of Bhimashankar and Udgiri. During the Nature camp at Dajipur Wildlife Sanctuary the members had a close encounter with gaur. Overnight Nature camps were arranged to study aquatic avifauna of the area near man-made wetlands like Nandur Madhmeshwar, Bhandardhara (Wilson Dam), Tansa lake. Nature camps were also arranged at Rehekuri, Sawantwadi, Murud-Janjira and Matheran.

Nature walk: Weekend outings were arranged at Borivli National Park, Yewoor trail, Tungareshwar, Kondgaon Lake, Kothligad and along Chillar River. Outings were also arranged at Goregaon creek and Kihim to study waders, at Godrej land to study mangrove flora and fauna and to study trees and other vegetations at Borivli National Park and Jijamata Udyan. Bird watching programmes were arranged at BNHS land at Goregaon (E) and at Borivli National Park. Bird Banding camp was organised at Kodaikanal.

Film/Slide shows: Video films on various subjects of Natural History interest were screened during the year. Slide shows-Magic of water, Monsoon flora of Sahyadri's, Harkidoon, wonders of nature, Trek from Kedarnath to Kalpeshwar, Gangotri the receding Glacier, and on Nature Education experiment were arranged for members.

Slide presentation was made by the participants of Nature Camp at Arunachal Pradesh and of Chopta.

From this year we introduced a series of popular scientific lectures like "Handicap Principle or the cost of a bright red comb for the male jungle fowl", "Landscape in evolution and the Redqueen Hypothesis", "fragmented forest, Planets of the apes", sea shore life. The talk "Use of waste heat energy for useful purpose particularly heat generation", and "sustainable rural development for earthquake affected Latur district" were of interest to all.

Wildlife week: First week of October was celebrated as Wildlife week. An exhibition of Wildlife photographs, postal stamps and Natural History specimens was organised.

Sálim Ali National Bird Count: The First Salim Ali National Bird Count was arranged on 14th November 1994. (Two days after 12th November the birthday of Late Dr Sálim Ali).

We are thankful to the Forest Officials connected with National Parks and Sanctuaries where our Nature camps were held. The Chief Wildlife Warden, Tamil Nadu for permitting to Bird Ringing Programme and members of the Society for Voluntary support, staff of Godrej park, Vikhroli, Film librarian, British Council, Bombay.

PRODUCTS

Products Officer - Mr Joslyn Rodrigues

The Products Department introduced 12 new designs of greeting cards and 2 calendars.

The gross sale for the last season amounted to Rs. 30 lakhs. Out of which 13.5 lakhs was a special order for wall calendar from M/s. Colour Chem Limited. A total of 2.38 lakhs cards and 75,000 calendars (special and BNHS) were sold.

The net earnings were in the range of Rs. 4 to 4.5 lakhs.

Special thanks are due to Mr Mantosh Lal (for designing the catalogue at subsidised rates) and Mr Atul Mathur for helping out with marketing strategies, etc.

The department also plans to include more ecofriendly items to tap the corporate gift market.

Besides cards and calendars, items on sale include publications, tea mugs, T Shirts, Stickers, haversacks, caps, and photographic prints. The marketing strategy adopted during the year was mainly by despatching catalogues to corporate houses, telemarketing and personal visits by our sales team. Efforts are being made to substitute imported art card with wood free paper.

PROJECTS

During the year the BNHS handled 7 major and minor projects and surveys. Bird Hazard Research Cell continues to function. The progress of research work is detailed below:

Birds of Prey Project (Budget Rs.39.21 lakhs)
Scientist in Charge : Dr Vibhu Prakash

Duration: January 1990-December 1992 Extension upto June 1994.

Term of the Project ended in March 1993. No cost extension upto June 1994 to complete residual work and the final report has been granted. Draft final technical report has prepared and sent to the funding authorities (US fish & Wildlife Services) for comments.

A workshop was conducted at Bharatpur for identification of raptors. Mr William Clark USFWS advisor and Dr Vibhu Prakash conducted the workshop. Research staff of BNHS and members participated in the workshop.

Grassland Ecology Project: (Budget Rs. 54.63 lakhs)

Scientist in Charge: Dr. Asad R. Rahmani

Duration: August 1990 — July 1995.

Research under this project continued in collaboration with Aligarh Muslim University. Research work continued at the field stations at Dahod (Gujarat), Nannaj (Mah.), Rollapadu (A.P.), Dudhwa (U.P.) and Fulay-Chhari (Kutch).

U.S. Advisor Prof. Mark Behan with Dr. A. R. Rahmani visited some of the field stations.

Radio Telemetry Studies of Elephant: (Budget Rs. 2.96 lakhs)

Scientist in Charge : Mr. Ajay Desai/Mr. N. Bhaskaran.

Duration: April 1993-March 1994.

Studies were continued for one year starting April 1993 with the funds from Ministry of Environment and Forests. Report is under preparation.

Birds of Sriharikota (Budget Rs.1.86 lakhs)

Scientist in Charge : Mr Prakash Rao

Duration: January 1993 — June 1994 (18 months).

Research work at Sriharikota continued throughout the year on this ISRO funded project.

Endangered Turtles of Pondicherry (Budget Rs.1.95 lakhs)

Scientist in Charge: Dr. S. Balachandran

Duration: December 1992-November 1993.

Research work on this project was concluded in November 1993. Final technical report has been prepared and submitted to the funding authorities.

Harrier Project: (Budget 0.43 lakhs)

Scientist in Charge: Mr. Asad Akhtar

Duration: November 1992-April 1993.

Study of roosting harriers at Velavadar National park was undertaken from Oct. 1993 to April 1994. A report has been prepared. The study was funded by the Hawk & Owl Trust, U.K.

Giant Squirrel Project: (Budget Rs.32.23 lakhs)

Principal Investigator: Dr. (Ms) Renee Borges.

Duration: September 1991-August 1996.

Observations were started on focal squirrel in the Bhimashanker Wildlife Sanctuary. Over 10,000 trees were marked and phenological data gathered. Position of all marked trees were mapped on a 50 square metre grid. Samples of dietary items were collected for laboratory analysis. Statistical and nutritional analysis of the data was also undertaken.

Final report on conservation problem and Mookambika Wildlife Sanctuary was submitted to Chief Wildlife Warden and Principal Chief Conservator of Forests, Karnataka.

Bird Migration Data analysis

Data collected during the project period 1980-1992 are being scrutinised in collaboration with Dept. of Statistics, University of Poona. A bio-statistician, Mr Prashant Muley, has been appointed for this work. So far tabulations for about 25 species have been completed. Migration patterns of migratory as well as resident birds are being analysed.

Concluded Projects

1. Point Calimere Ecological Project Ended in June 1991
2. Bird Migration Project Ended in September 1992
3. Elephant Ecology Project Ended September 1992

Permission for appropriation of assets belonging to above projects has been granted by the funding authorities.

PUBLICATIONS

Publications Officer: Mr. Ajay Varadachary

The Publications Division has been successful in making itself self-supporting, with its prime titles such as Book of Indian Birds, Book of Indian Animals and the Book of Indian Reptiles. The marketing and promotional support of the Oxford University Press, our sole selling agents, has helped to professionalize this Department and tap some of its potential as a substantial fund raiser for the Society.

The revisions of Pictorial Guide to the Birds of Indian Subcontinent and the Book of Indian Birds are well under way. The mammal and reptile books are under revision, while new titles on Indian Trees, Seashore life and Shells are being processed.

The HORNBILL series of booklets on various aspects of natural history are being prepared and 6 titles are near completion.

Hornbill magazine and the Journal of the Bombay Natural History Society are a resource drain, though some advertising support has been obtained for Hornbill. The Department of Science and Technology, Ministry of Science and Technology has given an additional grant amounting to Rs. 50,000/- towards production of the Journal. The deficit is met by the Society as the role of these two publications in popularizing natural history and disseminating scientific information is invaluable to the pursuance of the major aims of BNHS. Two issues of the Journal Vol. 90(1) and 90(2), and Hornbill Vol. 93(1) and 93 (2) were published during the year.

SALIM ALI NATURE CONSERVATION FUND

Conservation Officer: Mr. Goutam Narayan

Environmental awareness workshop for trekkers was organised at Bombay during August, 1993. 45 persons from trekking and climbing clubs participated. Assistance was given for organising workshop on "Avian Conservation — India". The Conservation Officer participated in this workshop. Financial assistance was given to Indian Peoples Tribunal on Environment and Human Rights.

The fourth Army Environment & Nature Conservation Workshop, was held at Dehradun, from 12 to 19 April 1993. Resource persons were drawn from the Wildlife Institute of India and other Institutes at Dehradun. Conservation officer also participated in the workshop, for the Army's Central Command.

Another Army Environment & Nature Conservation Workshop was conducted in the North-east at Missamari near Tezpur from 25 to 28 November 1993.

Assistance was provided in organising Wildlife week Programmes to create awareness among public.

BNHS (SANCF) was one of the co-convenors for the session on Forest, Wildlife and Tribal Rights at the Human Rights, Environment and Law Workshop (1 to 5 June 1993).

SANCF was one of the sponsors and co-ordinating agency for the International Seminar on "the Conservation of Asian Elephant" held at Mudumalai Wildlife Sanctuary from 13 to 18 June, 1993.

"Zoos and Conservation Education Workshop" was jointly organised on 28th & 29th January by SANCF, MCGB and ZOO Outreach organisation (ZOO). It was mainly conducted by Mr. Malcolm Whitehead of International Centre Of Conservation Education, U.K.; with Ms. Sally Walker of Zoo. Over 30 participants, attended the workshop at the Hornbill House and Zoo.

Dr. Jeremy Cherfas, the author and TV personality of Zoo 2000 fame from U.K., conducted the first workshop for the journalists "Role of Media in Conservation" on 18th January at the Hornbill House. The workshop was under the auspices of the Bombay Earth Forum established in 1992 by BNHS and the British Council (BDHC/BCD).

As the regional co-ordinator of the Asian Waterfowl Census for the states of Maharashtra, Madhya Pradesh and Goa, the Conservation Officer coordinated wetland bird count which commenced on 8th January 1994.

UNIVERSITY DEPARTMENT

Head, University Studies Department: Dr.. Jay Samant

We are happy to inform that the Bombay University has increased the quota of seats for M.Sc. by Research/ Ph.D. degree course in zoology from 10 to 30. The University has also given extension for M.Sc. by Research/Ph.D. in Botany till June 1995 and has also increased the quota of students from 6 to 10.

The details of the students who qualified or are working for M.Sc. or Ph.D. are given below:

Student	Degree	Guide	Subject
A. **Students who qualified**			
Mr. N.K. Ramchandran	Ph.D.	Dr. V. S. Vijayan	Comparative ecology of the phesant tailed and bronze winged Jacanas, Keoladeo National Park Bharatpur, Rajasthan.
Mr. Gurmeet Singh	M.Sc. (By research, Zoology)	Dr. R. B. Grubh	The ecology of the Bank Myna *Acridotheres ginginianus* (Latham) in an Urban environment.
Ms. Neelam Patil	M Sc. (By research, Botany)	Mr. M. R Almeida	Plant insect interaction.
B. **Students who have submitted thesis:**			
Mr..Bharat Bhushan	Ph.D.	Mr. J. C. Daniel	Birds of Eastern Ghats.
C. **Students continuing Research:**			
Mr..Prakash Rao	Ph.D.	Mr. J. C. Daniel	Bird communities of Tropics Dr.y evergreen forests of Sriharikotta Island.
Mr. N. Chaturvedi	Ph.D.	Mr. J. C. Daniel	Ecology of butterflies of the Borivli National Park.
Mr. Alagar Rajan	Ph.D.	Dr. R. B. Grubh	Avifauna of tropical Dr.y/evergreen forests of Point Calimere.
Mr. P. D. Vivek	Ph.D.	Dr. R. B. Grubh	Birds of Delhi Ridge.
Ms Nikita Prakash	M.Sc (by research)	Mr. J. C. Daniel	General Ecology of King Vulture in Keoladeo National Park.
Mr. S. Asad Akhtar	Ph.D.	Mr. J. C. Daniel	Ecology of Harriers wintering in India.
Mr. A. G. Sekar	Ph.D.	Dr.Jay Samant	Ecology of Amphibians of Northern Western Ghats.
D. **New Registrations: Zoology**			
Miss Ullal Vidya	Ph.D.	Dr. B. F. Chhapgar	Study of plankton of mangrove mudflats of Thane creek.
Ms. Hema Somnathan	Ph.D.	Dr. Jay Samant	Phenology and pollination biology of shrub species by insects.
Mr. Subhash Mali	Ph.D.	Dr. Jay Samant	Secondary metabolites and its role in food selection in the Malabar Giant Squirrel (*Ratufa indica*).
Mr. A. S. Brar	Ph.D.	Dr. Jay Samant	Study on the general ecology of storks (Fam. Ciconiidae) with special reference to black-necked storks in Keoladeo National Park.
Ms. DeepikaBharadwaj	M.Sc. (By Research, Zoology)	Dr. B.F.Chhapgar	Study of ecology of mangroves with associated fauna.
Ms. Subhalaxmi V.	M.Sc. (By Research, zoology)	Mr. N.Charturvedi	Ecology of moths of B.N.P. with special reference to Family Saturnidae and Spingidae.
Mr. S.R. Dubey	M.Sc. (By Research, Zoology)	Dr. B.F.Chhapgar	Alimentation and related studies on some fishes from Maharashtra
Ms. Seena F. Tharail	Ph.D. (Botany)	Dr. (Mrs.) Almeida	Taxonomy and Ecology of ferns growing in Trichur.

SUB-COMMITTEES OF THE EXECUTIVE COMMITTEE

The following office bearers were Ex-officio members of all the Sub-Committees.

Hon. Secreary	Mr. J.C. Daniel (up to Dec. 1993) Dr. Ashok Bhagwat (from Jan. 1994)
Hon. Treasurer	Mr. Sunil Zaveri
Director	Dr. Jay Samant

COLLECTIONS SUB-COMMITTEE

Chairman	Mr. M.R. Almeida
Members	Dr. B.F. Chhapgar Mr. Andy Mendonca Mr. Oswald Thayil
Convenor	Mr. N. Chaturvedi

CONSERVATION EDUCATION PROJECT

	Mr. Chandrakant Wakankar
Development Officer, BCD	Mr. Ramesh Dandekar
Project Field Manager	Mr. Aravind Karandikar
Project Administrator and Convenor	Mr. T.K. Bharatan

LIBRARY SUB-COMMITTEE

Chairman	Dr. Ashok Kothari
Members	Dr. B.F. Chhapgar Mr. Kiran Srivastava Ms. Doreen D'Sa Mr. V. K. Paralkar
Convenor	Mr. Isaac Kehimkar

MEMBERSHIP & PROGRAMME SUB-COMMITTEE

Chairman	Mr. Sunjoy Monga
Members	Dr. Ashok Kothari Mr. T. V. Sowrirajan Mr. P. B. Shekar
Convenor	Mr. N. Chaturvedi

NATURE EDUCATION SUB-COMMITTEE

Chairman	Dr. Parvish Pandya
Members	Dr. Arun Joshi Dr. Sanjay Bhagwat Mr. Vilas Shingre Mrs. Shobhana Bijoor Mrs. Sadhana Rasal
Convenor	Mrs. Shailaja Grubh

NATURAL HISTORY STUDIES SUB-COMMITTEE

Chairman	Dr. Erach Bharucha
Members	Mrs. D.S. Variava Dr. Pratap Saraiya Dr. B.F. Chhapgar Mr. M.R. Almeida Dr. A.M. Bhagwat Dr. Shashi Menon Dr. Parvish Pandya
Convenor	Dr. S.M. Satheesan

PERSONNEL SUB-COMMITTEE

Chairman	Dr. Jay Samant
Members	Mrs. D.S. Variava Dr. Pratap R Saraiya Dr. A.M. Bhagwat Mr. Yogi Andley
Convenor	Mr. N. Chaturvedi

PRODUCTS SUB-COMMITTEE

Chairperson	Mrs. D.S. Variava
Members	Mr. Mantosh Lal Mr. Atul Mathur Mr. Pritish Basu Mrs. Ranjana Shah
Convenor	Mr. J. Rodrigues

PROJECTS SUB-COMMITTEE

Chairperson	Dr. A.M. Bhagwat
Members	Mr. Humayun Abdulali Mr. Kisan Mehta Adm. M.P. Awati (Retd.) Mr. K.P. Karamchandani Mr. J.C. Daniel Dr. B.F. Chhapgar Dr. Renee Borges
Convenor	Mr. S.R. Nayak

PUBLICATIONS SUB-COMMITTEE

Chairman	Mr. J.C. Daniel
Members	Dr. Pratap Saraiya Mr. Bittu Sahgal Mr. Sunjoy Monga Dr. B.F. Chhapgar
Convenor	Mr. Isaac Kehimkar

SALIM ALI NATURE CONSERVATION FUND SUB-COMMITTEE

Chairman	Dr. Erach K. Bharucha
Members	Mrs. Dilnavaz S. Variava
Convenor	Mr. Goutam Narayan

UNIVERSITY STUDIES SUB-COMMITTEE

Chairman	Prof. P.V. Bole
Head, Univ. Dept.	Dr. Jay Samant (Director)
Members	Mr. M.R. Almeida Dr. B.F. Chhapgar Dr. Parvish Pandya Dr. Shashi Menon Dr. Renee Borges
Convenor	Mr. N. Chaturvedi

HONORARY TREASURER'S REPORT FOR THE YEAR ENDED 31ST MARCH 1994

I have pleasure to report on the 110th Annual Accounts of the Society and the following points may be higlighted while considering the Accounts and Auditors Report for the year 1993-1994:

1. During the year the Society has received permission to retain the Assets/Unspent Surplus of the projects. The said unspent surplus which has been allowed to be retained by the Society, amounts to Rs. 1,45,820.36. However, the same is a net of accumulated overruns on certain projects since closed. If there existed no overruns then the additional surplus to the Society would have been Rs. 12,75,823/-.
2. The Society has still not received any grant for the running and maintenance of airconditioners for Reference Collection Rooms, from the Government of India. This is so in spite of the Society fulfilling all the conditions as laid down by the concerned Ministry. The expenditure till date as receivable from the Government of India is Rs. 8,63,707.46. However, the Society is not hopeful of receiving the full amount. In such an event, the Society will have to consider appropriate action to be taken.
3. As the Society has not received any final stock position and the sales during the year from the Oxford University Press till the date of the declaration of the Annual General Meeting the income receivable and the surplus, if any, from the OUP sales remains to be taken into account.
4. On 29th of March 1993, the Society received the sanction letter from the Government of Maharashtra for upkeep, repairs, and maintenance of Hornbill House and its Collections. The amount has since been received and spent as per the sanction letter.
5. During the year, the Society has opted for the L.I.C. Group Gratuity Scheme. The Society has provided from its own funds Rs. 9,35,664/- for the creation of the BNHS Employees Group Gratuity Fund.
6. Last year, it was reported that the Society had started a vigorous exercise on internal control, internal checks and strict budgetary controls. I am happy to report that the exercise has yielded positive results.
7. Surplus on sale of products and publications has increased from Rs. 3.22 lacs of the year 92-93 to Rs. 11.50 lacs for the year 1993-94.
8. The above has resulted in the Society not facing a serious situation. In spite of the same, the Society still faces a crisis of inadequate funding to the tune of Rs. 18,87,919. This can be highlighted from the following:

A. FIXED CORPUS AND CAPITAL FUNDS

		31.3.1993	31.3.94
1.	Life Membership funds	18.30,325	19,90,515
2.	Corporate Life Membership Funds	2,25,742	2,25,742
3.	Vice Patron Funds	42,769	42,769
4.	Corpus Funds (Schedule 'A')	25,31,288	25,36,288
5.	Other Funds (Schedule 'B')	93,33,921	96,60,245
		1,39,64,045	1,44,55,559

B. ASSETS REPRESENTING THE ABOVE CAPITAL

1.	5.5% Government of India Loan	2,000	2,000
2.	Various Units of UTI	40,22,078	46,44,158
3.	Fixed Deposit with HDFC/ICICI/IDBI	15,00,000	25,00,000
4.	Vehicles	25,962	3,92,756
5.	Furniture, Fixtures and Equipments	18,89,008	25,45,692
6.	Stock of Books and Publications	3,52,877	15,46,765
7.	Bank Balance (other than project)	7,14,427	1,86,269
8.	FDR	17,54,158	7,50,000
		1,02,60,510	1,25,67,640
	* This is the shortfall 'A'-'B'	37,03,535	18,87,919

		31.3.1993	31.3.1994
	This is on account of the following:		
1.	Over-runs on projects	12,71,087	Nil
2.	Non-receipt of Govt. of India Air-conditioning Grant	6,44,838	8,63,707
3.	Non-receipt of Govt. of Maharashtra Grant	4,45,804	4,80,804
4.	Non-receipt of full amount of grants for the Journal, Collection expenses, Education Scheme, and other deficits and miscellaneous	13,41,806	5,43,408
		37,03,535	18,87,919

Thus the Society should, as soon as possible, cover the deficit in the capital funding to the tune of Rs. 18,87,919.

9. In the current year also the Society is pursuing its budgetary exercises with modification to provide for a good management information system. The same, till date, has not been fully functional but we are confident that till the year end it should be totally operational and the next year promises more hopes to the Society.

10. The Society now has a full-fledged Fund Raising Sub-Committee. The Committee has, till date, received the funds or the sanction advices of nearly Rs. 25,00 lacs. Notwithstanding the same, it is necessary to work harder and strive to raise more funds for the Society and get more projects in the field of conservation of nature and natural resources, research, environmental studies, awareness and education.

11. We have given the earlier year's figures for the sake of comparison.

For BOMBAY NATURAL HISTORY SOCIETY

Sd/-
Honorary Treasurer

Place: Bombay.
Dated: 12th September 1994.

AUDITORS' REPORT

Re: BOMBAY NATURAL HISTORY SOCIETY

Registration No. F-244 (Bom)

We have audited the attached Balance Sheet of the Society as at March 31, 1994 and also the annexed Income & Expenditure Account for the financial year ended on that date and report that in our opinion and to the best of our information and according to the explanation given to us:

(a) The accounts are maintained regularly and in accordance with the provisions of the Bombay Public Trust Act, 1950 subject to the observation that as per the past practice separate Receipts & Payments Account has been drawn for the Nature Education Scheme and the same has not been incorporated in the accounts of the Society. In this context, Rs. 1,51,353.37 is considered to be due from the Nature Education Scheme as at the end of the year. We have been given to understand that on settlement of the claim for arrears of the grant from the government, the entire amount would be adjusted,

(b) the receipts and disbursements have been properly, correctly shown in the accounts, subject to the observation that as per the accounting practice adopted, grants from State Government and other sponsoring organisations are being accounted in anticipation of receipt of sanction letters based on the claims preferred/to be preferred. While referring to the observations made in para (b) of our last report dated 27th Sept. 1993 accompanying the statement of accounts for the year ended March 31, 1993, we observe that the following items accounted in the previous year still remain unrealised:

Grant from State Govt.	Rs. 2,30,804/-
Central Govt. (Ministry of Environment & Forests) Grant for Air Conditioning of reference collection room and Library (*claim as revised)	*Rs. 6,05,713.40
Govt. of India (Environment & Forest) Grant for Nature Conservation Course for Indian Army	Rs. 1,00,000/-

We observe that in the case of Central Govt. grant for Air conditioning of reference collection room & library, the claim for expenditure incurred in the earlier year having been reviewed, a sum of Rs. 39,194.98 being considered ineligible for grant purpose, has been adjusted in the accounts for the year under report and expenditure of Rs. 2,57,994.96 incurred during the year towards electric charges and maintenance of Air Conditioning system has been treated as recoverable by way of grant. Thus the aggregate amount of grant accounted as receivable amounts to Rs. 8,63,707.46 as at the date of Balance Sheet. We also observe that a sum of Rs. 29,000/-, which had been accounted in the earlier year as grant recoverable for NOCIL Environment Study Project had to be written back, as the anticipated receipt did not materialise. We are not in a position to offer any comments about the realisability of the aforesaid outstanding dues. We reiterate our views that the income of such nature be recognised as income, when there is no uncertainty about its realisation. Incidentally, it may be pointed out that in the case of Nature Environment Course for Army, the Society has already incurred expenditure of Rs. 43,557.60 by the date of Balance Sheet,

(c) the cash balance and the vouchers in the custody of the accountant on the date of audit were in agreement with the books of accounts,

(d) the books, deeds, accounts, vouchers and/or other documents or records required by us were produced to us,

(e) the Register of movable and immovable properties has been maintained. However, the changes therein have remained to be communicated to the Regional Office. In the context of equipments and other such items of capital nature acquired out of various grants and other project funds, we observe that initially the cost of such equipments, etc., is charged to the relevant project accounts and on completion of the projects, the Society generally seeks the permission, of the concerned Sponsoring authorities to retain such assets, as are found to be useful for other projects and/or purposes and on obtaining such approvals, the necessary entries are passed in the books of accounts to record the residual value of such items. We observe that during the year under report value of certain assets so retrieved from the following projects have been brought into accounts on estimated basis. In the absence of any other audit evidence, we have relied on the estimates made by the management:

Keoladeo Ghana Sanctuary Project	Rs. 3,75,000
Study of Migration Patterns of Indian Birds	Rs. 4,50,000
Ecology of Indian Elephants	Rs. 2,50,000
Endangered Species/Florican	Rs. 1,25,000
Ecology of Pt. Calimere Sanctuary	Rs. 1,35,000
	Rs. 13,35,000

The said amount has been initially adjusted against the over run expenses under the first three named projects and the balance amount has been transferred to Income & Expenditure Account alongwith the unspent balance in the case of certain other projects, which we are informed, have been allowed to be retained and appropriated by the Society as detailed herein below:

Ministry of Environment & Forests (for purchase of service equipments)	7,355.60
Keoladeo Ghana Sanctuary Project	1,10,072.07
Ecology of Indian Elephant	24,210.93
Endangered Species/Florican	1,25,000.00
Ecology of Pt. Calimere Sanctuary	1,88,175.42
Study of the Migration Pattern of Indian Birds & Avifauna Migration Study Data Bank	(3,35,105.60)
Chief Wildlife Warden J & K for survey of Black necked Crane	26,111.94
	1,45,820.36

The relevant letters from the sponsoring authorities were however, not produced to us for our verification. We have placed reliance on the information and explanation that was furnished to us and we suggest that the value of the assets so brought into accounts and the amount of Rs. 1,45,820.36 so appropriated to Income & Expenditure Account be confirmed in the next Executive Committee meeting.

We also observe that certain vehicles, which had been likewise retrieved from some of the projects completed in some earlier years have been disposed off during the year and a sum of Rs. 1,80,151/- having been realised has been credited to Fixed Assets Fund.

On enquiry, we understand that pending certain clarification the value of a Jeep charged to certain project in the past years remain to be brought into account. In the absence of adequate information, it has not been possible for us to verify if the value of all the items allowed to be so retained has been adjusted.

While on the subject, we further understand that the Society is holding a number of 'medals' of different precious and semi precious metalic contents, which were awarded to late Dr. Sálim Ali and which under his Will have been obtained by the Society. The same, we are informed, are being held as commemorative souvenirs. The value thereof, has not been brought into accounts as it is contended that the said Souvenirs being of aesthetic and sentimental value and commemorative nature, the same can not be reduced to monetary value,

(f) the Hon. Treasurer and the Accountant appeared before us and furnished the necessary information required by us,

(g) we are not aware of any property or funds of the Society having been applied for any objects or purpose other than the objects of the Society,

(h) the following amounts were outstanding for more than one year:

— Dues towards supplies & services		40.287.30
— Loan to staff		13.500.00
— Advance for Expenses (for projects & other expenses):		
Employees	26.668.45	
Others	64.077.35	90,745.80
— Other dues		45.777.70
— Souvenir Advertisement		5.000.00
— Grant Receivable:		
From Govt. of Maharashtra		2,30.804.00
From Govt. of India		6,07,713.40
—do—		1.00.000.00
— Suspense Account		2,194.25

Included under the head 'other dues' are Rs. 6,534/- considered to be due from Bihar State Govt., which is being carried forward for the last few years and Rs. 10,252.25 representing three remittances made per Demand drafts which are stated to have been lost in transit. We are informed that the matter is being followed up in both the cases. Pending the outcome of these measures the amount has been considered as good by the management. The said item also includes Rs. 12,433.75 which have been incurred in connection with certain projects and pending certain clarification sought from the concerned sponsoring authorities have remained to be adjusted. We are not in a position to express any opinion about the realisability of these dues. In the context of the aforesaid outstanding of Rs. 26,148.45 representing advance to the employee, we understand that it includes Rs. 20,923.45 due from two persons, who are no longer in the employment of the Society and the said amount is proposed to be adjusted against the retirement dues payable by them. The advances to others (for project & other expenses) include Rs. 15,890.75 paid to certain organisation for certain project. It will be appreciated if proper account of the said advance is obtained from the said organisation and the account is appropriately adjusted. In regard to the balance in Suspense account, we suggest that effective steps be taken to recover the amount and clear the balance in suspense account.

Subject to the observations made in para (e) hereinabove, no amount has been written off during the year. We have been assured that the outstanding balances are considered good and recoverable,

(i) During the year under report there were no repairs or construction carried out involving an expenditure exceeding Rs. 5,000/- at any time,

(j) we are not aware of any money of the Society having been invested in contravention of Sec. 35 of the Bombay Public Trust Act, 1950,

(k) we are not aware of any immovable property of the Society, therefore, the question of alienation of any property contrary to the provisions of Sec. 36 of the Bombay Public Trust Act, 1950 does not arise,

(l) i) in regard to the expenses charged to various grants and funds we have relied on the information given to us and the authentication of the Hon. Secretary and Hon. Treasurer that the expenses so charged relate to these grants and have been spent on the specific objects for which the grants were received. While checking the statement of accounts in regard to the expenditure incurred at various camps, we have relied on the authorisation by the Hon. Secretary and Hon. Treasurer, as to the reasonableness of the expenditure,

ii) while on the above subject, we observe that some of the local field workers, whose services were engaged for the said project at Bharatpur, are claiming reinstatement and other service benefits, which is being disputed by the Society. The contingent liability in this regard remains underterminate. The matter, we are informed, is pending before the Labour Court at Bharatpur and Provident Fund authorities. An ad-hoc provision of Rs. 2,83,991/- has been made in the accounts by debiting various projects accounts. The liability has not been determined on actuarial basis,

iii) the income towards membership subscription is being accounted on realisation basis,

iv) while referring to the observations made in para (1(iv) of our aforementioned report dated 27th Sept. 1993, we observe that the account maintained with the Grindlays Bank, London has been closed during the year under report and the exchange difference of Rs. 2,908.04 arising at the time of closure of the account has been credited to Income & Expenditure account,

v) we are given to understand that on physical verification of the fixed assets certain items were found to be lying with some members for research/study purpose. We suggest that proper records in this regard may be maintained & year and confirmation be obtained from such borrowing members,

vi) we suggest the following items of disbursements effected, appropriations made and administrative charges levied be confirmed and ratified at the next meeting of the Executive committee,

A. DISBURSEMENT FROM

i)	Sálim Ali Nature Conservation Fund Investment Revenue Account	1,52,100.25
ii)	Sálim Ali — Lok Wan Tho Ornithological Fund Investment Revenue Account	3,023.50
iii)	Pirojsha Godrej Foundation Fieldwork Fund Investment Revenue Account	4,300.00
iv)	Col. Burton Nature Conservation Fund Investment Revenue Account	86.12
v)	Charles McCann Vertebrate Zoology Field-work Fund	26,450.00
vi)	Education and Research Fund created out of Income	8,412.00
vii)	Sálim Ali Memorial Fund	387.00
viii)	Staff Gratuity Fund	11,07,896.00
ix)	Ministry of Defence, AR&DB, for Bird Hazard Research Cell	1,73,659.10
x)	Department of Space, Ecological Investigation of Avian Community of Sriharikota	83,405.90
xi)	Elephant Telemetry Projects	2,82,879.85
xii)	Ministry of Environment & Forests — Nature Conservation Course — Indian Army	24,887.95
xiii)	Grants from United States, Department of Interior, Fish and Wildlife Service for:	
a)	Ecology of Dry Grassland	9,60,410.80
b)	Ecology of Point Calimere Sanctuary	24,865.00
c)	Study of the Migration Patterns of Indian Birds and Avifauna Migration Study Data Bank	4,736.00
d)	Study of Conservation of Birds of Prey with particular emphasis upon restoration of Endangered Species	4,77,536.60
xiv)	Hawk & Owl Trust — Grassland & Roosting Harriers	56,490.65
xv)	Endangered Turtles of Pondicherry	95,350.15
xvi)	Wetland, Mangrove & Coral Reefs in India (UNDP)	11,420.60
xvii)	Smithsonian Institution, Washington, for revision of 'The Handbook of Birds of India and Pakistan'	28,871.70
xviii)	Neyveli Lignite Corporation Limited for Environmental Study at Rajasthan Plant	3,78,064.35
xix)	Grant from Chilka Lake	14,000.00
xx)	Grant from Gujarat Ambuja Cement Co. Ltd. for Enviromental Study	11,138.00
xxi)	National Organic Chemical Industries Ltd. for Environmental Study	74,086.45
xxii)	Grant from Govt. of Maharashtra for 1993-94 towards Establishment, Building Maintenance, Educational activity	2,50,000.00
xxiii)	Conservation Education Project	34,84,036.79

B. APPROPRIATIONS

i)	Proposed Institution	5,00,000.00
ii)	Charles McCann Vertebrate Zoology Fieldwork Fund	600.00
iii)	Sálim Ali Memorial Fund	2,00,000.00
iv)	Publication Fund — BNHS	50,000.00
v)	General Reserve Fund	2,00,000.00
vi)	Staff Gratuity Fund	2,00,000.00
vii)	Staff Welfare Fund	1,00,000.00
viii)	Fixed Assets Fund towards depreciation on Fixed Assets	4,61,859.12

C.	Administrative Fees charged to various Grants/Funds for handling the projects, etc.	10,52,926.19
D.	Addition to Fixed Assets	14,85,354.00

(1) vii) The balance of Rs. 1,21,685.52 in Sundry Debtors A/c. for supplies & services has been taken as per the balance appearing in the General Ledger. The same remains to be reconciled with Subsidiary Ledger. In the absence of such reconciliation, the advances received have not been segregated and shown separately.

viii) We observe that the contribution to Employees' Provident Fund (both the employees and management contribution) continues to be deposited with the Trustees of a recognised provident fund established by the Society, and governed by the rules framed for the purpose. There seems to have been certain amendments to the Employees' Provident Fund and Miscellaneous Provisions Act, 1952, whereunder the Society may be considered to be liable not only to transfer the accumulated balance in the Employees' Provident Fund A/c. to the Provident Fund Commissioner Govt. Scheme, but also for the difference in the amount of contribution. The liability in this regard remains underterminate. We suggest that proper legal opinion may be sought in this regard and needful may be done in the matter,

(m) So far as it is ascertainable from the books of accounts and according to the information and explanation furnished to us by the Hon. Treasurer and the Hon. Secretary, there were no cases of irregular , illegal or improper expenditure or failure to recover the money or other properties belonging to the Society or loss or waste of money or other property of the Society, subject to the observations made in para (h) hereinabove,

(n) provisions of Section 31-A of the Bombay Public Trust Act, 1950 and Rule 16-A of the Rules framed under the said Act have been complied with,

(o) the maximum and minimum number of Executive Committee Members is maintained having regard to the provisions contained in the Rules and Regulations of the Society.

(p) there is no specific provisions in the Rules and Regulations of the Society regarding the holding of the meetings of the Executive Committee,

(q) the minute book recording the proceedings of the meetings is maintained,

(r) no member of the Executive Committee has any interest in the investment of the Society,

(s) in the absence of a list of outstanding dues and advances for supplies and services duly reconciled with the financial books being produced to us, we are not in a position to aver if any amounts are due to/from any members of the Executive Committee,

(t) there were no irregularities pointed out in our last report dt. 27.9.93 accompanying the statement of accounts for the year ended March 31, 1993 except the observations made in paras (e), (h), the observations whereof have been reiterated hereinabove to the extent the issues remain still outstanding.

CHARTERED ACCOUNTANTS

Bombay,
12th September, 1994.

BOMBAY NATURAL HISTORY SOCIETY

BALANCE SHEET FOR THE YEAR ENDED 31ST MARCH, 1994
BOMBAY PUBLIC TRUST ACT, 1950
SCHEDULE VIII VIDE RULE 17(1)

Regn. No. F-244 (Bom)

Previous year 1992-93 Rs.	FUNDS AND LIABILITIES	Rs.	Current year 1993-94 Rs.	Previous Year 1992-93 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1993-94 Rs.
	LIFE MEMBERSHIP FUND						
	(INDIVIDUALS)				**INVESTMENTS (AT COST)**		
16,89,995.16	Balance as per Last Balance Sheet	18,30,325.16					
1,40,330.00	Add: Received during the year	1,60,189.96			5.5% Govt of India Loan 2000		
18,30,325.16			19,90,515.12		of the Face Value Rs.2000/-		
				2,000.00	(Market Value Rs.1365/-)		2,000.00
	CORPORATE						
	LIFE MEMBERSHIP FUND				8530 Units of Unit Trust of India		
2,15,742.31	Balance as per last Balance Sheet	2,25,742.31			Under CRTS 1981		
10,000.00	Add: Received during the year	Nil		8,53,000.00	of the Face Value Rs.100/- Each	8,53,000.00	
2,25,742.31			2,25,742.31		(Repurchase Value Rs.9,59,635.00)		
					70150 Units of Unit Trust of India		
	VICE PATRON FUND				Under Unit Scheme 1964		
42,769.00	Balance as per last Balance Sheet		42,769.00	9,99,637.50	of the Face Value Rs.10/- Each	9,99,637.50	
					(Repurchase Value Rs.12,41,655.00)		
	CORPUS FUNDS						
25,31,287.97	As Per Schedule 'A'		25,36,287.97				
					4940 Units of Unit Trust of India		
					Under CRTS 1981		
	OTHER FUNDS			4,94,000.00	of the Face Value Rs.100/- Each	4,94,000.00	
93,33,920.68	As Per Schedule 'B'		96,60,244.63		(Repurchase Value Rs.5,55,750.00)		
	CURRENT LIABILITIES				4770 Units of Unit Trust of India		
	For Unspent Grants				Under CRTS 1981		
29,60,634.71	as per Schedule 'C'	38,31,762.12		4,77,000.00	of the Face Value Rs.100/- Each	4,77,000.00	
4,86,167.98	For Expenses	6,74,210.44			(Repurchase Value Rs.5,36,625.00)		
6,100.00	For Library Deposits	8,200.00					
1,54,032.29	For Sundry Credit Balances	50,573.31			4850 Units of Unit Trust of India		
29,639.87	For Advances for Publications	30,426.11			Under CRTS 1981		
36,36,574.85	and Products		45,95,171.98	4,85,000.00	of the Face Value Rs.100/- Each	4,85,000.00	
					(Repurchase Value Rs.5,45,625.00)		
	Carried over		1,90,50,731.01	33,08,637.50	Carried over	33,08,637.50	2,000.00

Previous year 1992-93	FUNDS AND LIABILITIES		Current year 1993-94	Previous Year 1992-93	PROPERTIES AND ASSETS		Current Year 1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	Brought over		1,90,50,731.01	33,08,637.50	Brought over	33,08,637.50	2,000.00
					(Investments (at cost) (contd.)		
					5000 Units of Unit Trust of India		
	OTHER LIABILITIES				Under US 1964 Plan		
	Amount Received For & On Behalf			7,00,000.00	of the Face Value Rs.10/- Each	7,00,000.00	
2,48,086.11	of Proposed Institute		Nil		(Repurchase Value Rs.8,85,000.00)		
	INCOME &				1200 Units of Unit Trust of India		
	EXPENDITURE ACCOUNT				Under US 1964 Plan		
46,687.96	Balance As Per Last Balance Sheet	84,410.86		13,440.00	of the Face Value Rs.10/- Each	13,440.00	
					(Repurchase Value 21,240.00)		
37,722.90	Add: Excess of Income over expenditure during the year	26,501.13		40,22,077.50			
84,410.86			1,10,911.99		48,600 Units of Unit Trust of India		
					Under US 1964 of Face Value Rs.10/-		
					each.		
					(Repurchase Value Rs.8,60,220.00)	6,22,080.00	
				Nil			46,44,157.50
					Fixed Deposits with		
				15,00,000.00	Housing Development Corpn. Ltd.	15,00,000.00	
				Nil	ICICI	5,00,000.00	
				Nil	IDBI	5,00,000.00	
							25,00,000.00
					VEHICLES		
				32,453.43	Balance As Per Last Balance Sheet	25,962.74	
					Add: Addition during the year	4,65,000.00	
						4,90,962.74	
					Less: W.D.V. of vehicle sold	18.22	
						4,90,944.52	
				6,490.69	Less: Depreciation during the year	98,188.90	
				25,962.74			3,92,755.62
					FURNITURE, FIXTURES & EQUIPMENTS		
				21,33,974.29	Balance As Per Last Balance Sheet	18,89,007.79	
				24,891.50	Add: Additions during the year	10,20,354.00	
				21,58,865.79		29,09,361.79	
				2,69,858.00	Less: Depreciation during the year	3,63,670.22	
				18,89,007.79			25,45,691.57
1,76,90,751.83	Carried over		1,91,61,643.00		Carried over		100,84,604.69

Previous year 1992-93	FUNDS AND LIABILITIES		Current year 1993-94	Previous Year 1992-93	PROPERTIES AND ASSETS		Current Year 1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
1,76,90,751.83	Brought over		1,91,61,643.00		Brought over		100,84,604.69
					LOANS		
					(Unsecured Considered Good)		
				69,320.00	To Employees		1,03,479.00
					ADVANCES		
					(Unsecured Considered Good)		
					To Employees		
				4,28,646.60	For Project & Other Expenses	4,65,539.05	
					To Others		
				2,23,250.66	For Project & Other Expenses	1,81,206.76	
				Nil	Against repairs to motor car	15,000.00	
					Advances against salaries		
				4,010.00	to Employees	4,956.00	
				Nil	Against equipment	36,500.00	
				1,62,386.62	Dues from Nature Education Scheme	1,51,353.37	
				Nil	Advance for rent	4,500.00	
				867.57	Dues from Unit Trust of India	Nil	
				Nil	Computer Maintenance	1,25,000.00	
					Other dues for Travel and other		
				1,91,357.90	expenses	Nil	
				10,10,519.35			9,84,055.18
					DEPOSITS		
				68,130.00	BEST Undertaking	77,270.00	
				11,000.00	Mahanagar Telephone Nigam Ltd.	15,000.00	
				11,000.00	P & T Dept. for Project Telephones	11,000.00	
				1,000.00	NCST for Eletronic Mailing	1,000.00	
				8,950.00	Gas Cylinder for Projects	9,850.00	
				561.00	Elec. Deposit for Projects	561.00	
				2,500.00	For Vehicle Fuel Supply	2,500.00	
				420.15	For Franking Machine	420.15	
				1,78,396.00	For Accommodation	2,28,396.00	
				Nil	For Burner	50.00	
				Nil	Security Deposit (CEP)	40,000.00	
				2,81,957.15			3,86,047.15
1,76,90,751.83	Carried over		1,91,61,643.00		Carried over		1,15,58,186.02

Previous year 1992-93	FUNDS AND LIABILITIES		Current year 1993-94	Previous Year 1992-93	PROPERTIES AND ASSETS		Current Year 1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
1,76,90,751.83	Brought over		1,91,61,643.00		Brought over		1,15,58,186.02
					STOCKS		
					As Per Inventories Taken And Certified By the Hon.Secretary		
				3,10,987.32	BNHS Publications	14,03,907.82	
				41,890.80	Govt Publications	1,42,857.00	
				86,389.08	Greeting Cards	98,946.00	
				715.00	BNHS T Shirts	1,760.00	
				2,796.50	BNHS Mugs	2,632.00	
				—	BNHS Caps	7,258.00	
				3,100.00	Rare Painting Photographs	Nil	
				—	BNHS Bags	4,439.00	
				—	BNHS Sticker	5,788.75	
				4,45,878.70			16,67,588.57
					BOOKS UNDER PUBLICATION		
					(Expenses Incurred Till Date)		
				1,55,305.00	Book of Indian Birds reprint edition	1,70,625.00	
				22,891.36	Some Beautiful Indian Trees	Nil	
				1,78,196.36			1,70,625.00
					INCOME OUTSTANDING		
				2,02,568.40	Interest Accrued	2,00,385.12	
				2,45,833.75	For Publications	6,378.20	
				70,081.20	For Greeting Cards	44,543.40	
				23,119.50	For Calendars	70,763.92	
				5,350.00	For Souvenir Advertisements	5,000.00	
				36,000.00	For Hornbill Advertisements	Nil	
				40,157.75	For Xerox Charges	11,980.00	
				6,23,110.60			3,39,050.64
1,76,90,751.83	Carried over		1,91,61,643.00		Carried over		1,37,35,450.23

Previous year 1992-93	FUNDS AND LIABILITIES		Current year 1993-94	Previous Year 1992-93	PROPERTIES AND ASSETS		Current Year 1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
1,76,90,751.83	Brought over		1,91,61,643.00		Brought over		1,37,35,450.23
					GRANTS RECEIVABLE		
				29,000.00	From NOCIL	Nil	
				2,31,710.00	From AR&DB	Nil	
				1,80,000.00	From Neyveli Lignite Corpn. Ltd.	Nil	
				6,44,838.38	From Govt. of India (Reference Collection airconditioning Exp.) (Expenditure (net) for the year Rs.218869.08)	8,63,707.46	
				4,45,804.00	From Govt. of Maharashtra (1992-93 and 1993-94)	4,80,804.00	
				Nil	From Govt. of India (Environment and Forests) Elephant Telemetry Project	2,96,000.00	
				1,00,000.00	Course for Indian Army	1,00,000.00	
				Nil	From Govt. of Maharashtra for upkeeping, repairs to Hornbill House and Collection	8,92,000.00	
				16,31,352.38			26,32,511.46
				Nil	Income Tax (TDS)		11,279.00
					CASH AND BANK BALANCES		
				47,40,282.66	As Per Schedule D		27,82,402.31
1,76,90,751.83	Carried over		1,91,61,643.00		Carried over		1,91,61,643.00

Previous year 1992-93	FUNDS AND LIABILITIES		Current year 1993-94	Previous Year 1992-93	PROPERTIES AND ASSETS		Current Year 1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
1,76,90,751.83	Brought over		1,91,61,643.00		Brought over		1,91,61,643.00
					UNADJUSTED DEFICIT ON PROJECTS		
				2,64,927.93	(a) Keoladeo Ghana Sanctuary Project	Nil	
				7,80,360.60	(b) Study of Migration patterns of Indian Birds	Nil	
				2,25,789.07	(c) Ecology of Indian Elephants	Nil	Nil
1,76,90,751.83	Total Rs.		1,91,61,643.00	1,76,90,751.83	Total Rs.		1,91,61,643.00

BOMBAY NATURAL HISTORY SOCIETY

Sd/-

HONORARY SECRETARY

Sd/-

HONORARY TREASURER

Bombay,
12th September, 1994

AS PER OUR REPORT OF EVEN DATE

Sd/-

HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31ST MARCH 1994
SCHEDULE A : CORPUS FUNDS

Name of the Corpus Fund	Balance As Per Last Balance Sheet 1	Amounts Received/ Appropriated during the year 2	Total of Columns 1 & 2 3	Balance As On 31-3-1994 4
	Rs.	Rs.	Rs.	Rs.
Salim Ali Nature Conservation Fund	20.76,668.45	5.000.00	20.81,668.45	20,81.668.45
Salim Ali / Loke Wan Tho Ornithological Research Fund	4,03,136.52	—	4,03,136.52	4,03,136.52
Pirojsha Godrej Foundation Fieldwork Fund	40,000.00	—	40,000.00	40,000.00
Col.Burtons Nature Conservation Fund	11,483.00	—	11,483.00	11,483.00
Total Rs.	25,31.287.97	5,000.00	25,36.287.97	25,36,287.97

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31ST MARCH 1994
SCHEDULE B : OTHER FUNDS

Name of the Other Fund	Balance As Per Last Balance Sheet	Amount Recd/ Appropriated during the year	Interest Credited during the year	Total of Columns 1, 2 & 3	Transferred to Income & Expenditure Account during the year	Expenditure on objects of Trust / Other Exps as shown in Income & Exp Account	Balance as on 31-3-1994
	1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Sálim Ali Nature Conservation Fund Investment Revenue Account	2.24.246.85	—	2.07,666.85	4,31,913.70	1.52.100.25	1.52.100.25	2.79,813.45
Sálim Ali - Loke Wan Tho Ornithological Fund Investment Revenue Account	1.10.003.25	—	40.313.65	1.50.316.90	3.023.50	3.023.50	1,47,293.40
Pirojsha Godrej Foundation Fieldwork Fund Investment Revenue Account	11.650.49	—	4.000.00	15.650.49	4.300.00	4.300.00	11.350.49
Col. Burton Nature Conservation Fund Investment Revenue Account	4.424.99	—	1.148.30	5,573.29	86.12	86.12	5.487.17
Charles MaCann Vertebrate Zoology Fieldwork Fund	1.08.251.46	600.00	10.825.15	1.19.676.61	26.450.00	26,450.00	93.226.61
Plant Study Fund	43.774.80	—	—	43.774.80	—	—	43.774.80
Education & Research Fund Created Out of Income	60,174.76	—	—	60.174.76	8.412.00	8.412.00	51,762.76
Chacko Fund For Education And Conservation	37,559.70	—	—	37,559.70	—	—	37,559.70
Salim Ali Memorial Fund	22,87.568.99	2.00.000.00	—	24.87.568.99	387.00	387.00	24.87.181.99
Publication Fund - BNHS	14.47.692.27	2.66.095.45	—	17.13.787.72	—	—	17.13.787.72
Publication Fund From Govt of India Dept of Science & Technology	5.23.689.02	1.05.443.56	—	6.29.132.58	—	—	6.29.132.58
Fixed Assets Fund	16.22.675.49	2.30.532.78	—	18.53.208.27	4.61,859.12	4.61,859.12	13,91.349.15
Building Fund	5.03.227.68	—	—	5.03.227.68	—	—	5.03.227.68
Carried over ...	69.84.939.75	8.02.671.79	2,63,953.95	80.51.565.49	6.56.617.99	6.56.617.99	73.94.947.50

Schedule 'B' (contd..)

Name of the Other Fund	Balance As Per Last Balance Sheet	Amount Recd/ Appropriated during the year	Interest Credited during the year	Total of Columns 1, 2 & 3	Transferred to Income & Expenditure Account during the year	Expenditure on objects of Trust / Other Exps as shown in Income & Exp Account	Balance as on 31-3-1994
	1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over ...	69,84,939.75	8,02,671.79	2,63,953.95	80,51,565.49	6,56,617.99	6,56,617.99	73,94,947.50
General Reserve Fund	7,33,638.22	2,00,000.00	-	9,33,638.22	-	-	9,33,638.22
Staff Gratuity Fund	10,79,963.81	2,00,000.00	-	12,79,963.81	11,07,896.00	11,07,896.00	1,72,067.81
Staff Welfare Fund	2,01,505.34	1,04,212.00	-	3,05,717.34	-	-	3,05,717.34
Donation From Seth Purshotamdas Thakurdas & Divaliba Charitable Trust For Publication of Tree Book	75,000.00	-	-	75,000.00	-	-	75,000.00
Proposed Institute Fund	2,58,873.76	5,00,000.00	20,000.00	7,78,873.76	-	-	7,78,873.76
	93,33,920.88	18,06,883.79	2,83,953.95	1,14,24,758.62	17,64.513.99	17,64,513.99	96,60,244,63

Summary Of Expenditure From Funds/Donations

Expenditure Head		**Amount** Rs.
Expenses on objects:		
Nature Conservation	1,52,100.25	
Natural History Study	39,248.12	
Other Educational expenses	3,023.50	
		1,94,371.87
Others		
Miscellaneous :		
Beautification of Dr Salim Ali Chowk		387.00
Gratuity to staff		11,07,896.00
Depreciation		4,61,859.12
Total Rs.		17,64,513.99

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31ST MARCH, 1994
SCHEDULE C : GRANTS

Name of the Grant	Balance As Per Last Balance Sheet	Amount Recd./ Receivable during the year	Total of Columns 1 & 2	Transferred To Income & Expenditure Account during the year	Expenditure On Objects of Trust / Other Exps As Shown In Income & Exp Account	Balance As On 31-3-1994
	1	2	3	4	5	6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
GRANTS FROM GOVT OF INDIA						
Ministry of Defence, ARDB						
For Bird Hazard Research Cell	2,11,044.31	—	2,11,044.31	1,73,659.10	1,73,659.10	37,385.21
Elephant Telemetry Project	—	2,96,000.00	2,96,000.00	2,82,879.85	2,82,879.85	13,120.15
Ecology of Jerdon's Courser	—	49,000.00	49,000.00	—	—	49,000.00
Ministry of Environment & Forests For Purchasing Scientific Equipments during 1988-89 Continued In 1989-90	7,355.60	—	7,355.60	7,355.60	—	Nil
Dept of Science & Technology						
For Publication of Tree Book	51,873.10	—	51,873.10	—	—	51,873.10
Deptt. of Space: Ecological Investigation of Avian Community of Sriharikota	90,087.30	—	90,087.30	83,405.90	83,405.90	6,681.40
Dept. of Science & Technology NCSTC - For publications of Hornbill Series	2,40,000.00	—	2,40,000.00	—	—	2,40,000.00
Ministry of Environment & Forests Nature Conservation Course - Indian Army	68,445.55	—	68,445.55	24,887.95	24,887.95	43,557.60
GRANTS FROM UNITED STATES DEPT OF INTERIOR, FISH & WILDLIFE SERVICE FOR RESEARCH PROJECTS						
Ecology of Dry Grasslands	7,84,215.57	9,24,532.00	17,08,747.57	9,60,410.80	9,60,410.80	7,48,336.77
Carried over	14,53,021.43	12,69,532.00	27,22,553.43	15,32,599.20	15,25,243.60	11,89,954.23

Schedule 'C' (Contd....)

Name of the Grant	Balance As Per Last Balance Sheet	Amount Recd./ Receivable during the year	Total of Columns 1 & 2	Transferred To Income & Expenditure Account during the year	Expenditure On Objects of Trust / Other Exps As Shown In Income & Exp Account	Balance As On 31-3-1994
	1	2	3	4	5	6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	14,53,021.43	12,69,532.00	27,22,553.43	15,32,599.20	15,25,243.60	11,89,954.23
Ecology of Keoladeo Ghana Sanctuary, Bharatpur, Rajasthan	-2,64,927.93	3,75,000.00 (Note-1)	1,10,072.07	1,10,072.07	-	Nil
Ecology of Indian Elephant	-2,25,789.07	2,50,000.00 (Note-1)	24,210.93	24,210.93	-	Nil
Ecology of Pt. Calimere Sanctuary	78,040.42	1,35,000.00 (Note-1)	2,13,040.42	24,865.00 1,88,175.42	24,865.00	Nil
Study of the Migration Patterns of Indian Birds and Avifauna Migration Study Data Bank	-7,80,369.60	4,50,000.00 (Note-1)	-3,30,369.60	4,736.00 -3,35,105.60	4,736.00	Nil
Study of Conservation of Birds of Prey with particular emphasis upon Restoration of Endangered Species	6,25,404.80	-	6,25,404.80	4,77,536.60	4,77,536.60	1,47,868.20
Endangered species/Florican	-	1,25,000.00 (Note-1)	1,25,000.00	1,25,000.00	-	Nil
OTHER GRANTS						
Chief Wildlife Warden Jammu & Kashmir For survey of Blacknecked Crane	26,111.94	-	26,111.94	26,111.94	-	Nil
Smithsonian Institution, Washington For Revision of 'the Handbook of Birds of India & Pakistan'	29,480.47	-	29,480.47	28,871.70	28,871.70	608.77
Neyveli Lignite Corporation Ltd. For Environment Study At Rajasthan Plant	3,78,064.35	-	3,78,064.35	71,298.50 3,06,765.85	71,298.50 3,06,765.85	Nil
Carried over ...	13,19,036.81	26,04,532.00	39,23,568.81	25,85,137.61	24,39,317.25	13,38,431.20

Schedule 'C' (Contd....)

Name of the Grant	Balance As Per Last Balance Sheet	Amount Recd./ Receivable during the year	Total of Columns 1 & 2	Transferred To Income & Expenditure Account during the year	Expenditure On Objects of Trust / Other Exps As Shown In Income & Exp Account	Balance As On 31-3-1994
	1	2	3	4	5	6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	13,19,036.81	26,04,532.00	39,23,568.81	25,85,137.61	24,39,317.25	13,38,431.20
Gujarat Ambuja Cement Co.Ltd. For Environmental Study	11,138.00	—	11,138.00	11,138.00	11,138.00	Nil
National Organic Chemical Industries Ltd. For Environmental Study	74,086.45 (Note-2)	—	74,086.45	74,086.45	74,086.45	Nil
Hawk & Owl Trust - Grassland Roosting Harriers	40,873.25	27,523.00	68,396.25	56,490.65	56,490.65	11,905.60
Endangered Turtles of Pondicherry	99,424.40	—	99,424.40	95,350.15	95,350.15	4,074.25
Wetland, Mangroves and Coral Reefs in India (UNDP)	1,15,989.20	—	1,15,989.20	11,420.60	11,420.60	1,04,568.60
Grant for Chilka Lake Project	—	15,000.00	15,000.00	14,000.00	14,000.00	1,000.00
Govt. of Maharashtra, for upkeeping, repairs and maintenance of Hornbill House and Collection	—	8,92,000.00	8,92,000.00	—	—	8,92,000.00
Conservation Education Project	—	49,63,819.26	49,63,819.26	34,84,036.79	34,84,036.79	14,79,782.47
Total	16,60,548.11	71,67,874.26	1,01,63,422.37	61,85,839.89	61,85,839.89	38,31,762.12
Total		13,35,000.00		1,45,820.36		

Note-1 : Estimated value of the Fixed Assets allowed to be retained by the Society.

Note-2: Net of adjustment for unrealised grant.

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31-3-1994
SCHEDULE D : CASH AND BANK BALANCES

	Rs.	Rs.
A. In Current Account With		
ANZ Grindlays Bank p.l.c. M.G.Road Branch		9,874.38
B. In Savings Account With		
ANZ Grindlays Bank p.l.c. M.G.Road Branch	79,320.27	
Bank of India Museum Savings Branch	85,726.55	
State Bank of India Gateway of India Branch	57,777.30	
State Bank of India (CEP)	13,97,978.52	
Canara Bank Sir P.M.Road Branch	2,604.95	
Corporation Bank Dalal Street Fort Branch	68,801.11	
Corporation Bank Dalal Street Fort Branch (FCRA Account)	11,348.23	
Deutsche Bank, Bombay Branch	18,971.00	
		17,22,527.93
C. In Fixed Deposit With		
ANZ Grindlays Bank p.l.c. M.G.Road Branch	1,00,000.00	
Corporation Bank Dalal Street Fort Branch	2,00,000.00	
Deutsche Bank, Bombay Branch	7,50,000.00	
		10,50,000.00
	Total Rs.	27,82,402.31

Regn. No. F-244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 1994

Previous year 1992-93	EXPENDITURE		Current year 1993-94	Previous Year 1992-93	INCOME		Current Year 1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	EXPENDITURE IN RESPECT				**INTEREST (RECEIVED & ACCRUED)**		
	OF PROPERTIES			110.00	On Govt Securities	110.00	
4,926.00	Municipal Taxes	9,489.00		5,71,619.60	On Fixed Deposits	3,40,925.93	
278.00	Building Insurance	278.00		38,737.54	On Saving Accounts	23,499.35	
15,535.00	Building Maintenance	6,850.00		Nil	On ICICI Bonds	52,562.00	
				Nil	On IDBI Bonds	60,358.50	
20,739.00			16,617.00	6,10,467.14			4,77,455.78
	ESTABLISHMENT EXPENSES			8,22,088.50	Distn. of Income from UTI		7,30,432.00
	Salaries of Reference Collection						
4,35,257.00	and Maintenance staff	5,35,437.75			**DONATIONS**		
10,73,508.00	Salaries to other staff	13,12,326.95			For Specific Purposes :		
19,920.00	Leave Travel Allowances	36,083.40		560.00	SANCF Corpus Fund	5,000.00	
19,797.30	Medical Allowances	22,000.00		1,736.00	Salim Ali Memorial Fund	Nil	
31,281.00	Compensation to staff	68,400.00		Nil	Publication Fund	2,00,000.00	
7,737.40	Uniform and umbrellas to staff	Nil			Charles MaCann Vertebrate		
3,600.00	Washing Allowances	4,110.00		600.00	Zoology Fund	600.00	
	Management's contribution to			20,000.00	Hornbill printing	25,000.00	
65,434.00	Provident Fund	84,588.00		Nil	General Donations	1,87,549.00	
6,346.00	Gratuity paid to staff	1,72,232.00		4,04,585.18	For Various projects	2,00,000.00	
	Premium paid to BNHS Employees'						
Nil	Group Gratuity Scheme	9,35,664.00		4,27,481.18			6,18,149.00
	(including Rs.9,08,071.00 for						
	past services)				**GRANTS**		
11,146.00	Casual Labour	9,190.10			From Govt. of Maharashtra for		
52,283.35	Meeting Expenses	53,525.50			Establishment Expenses for 1993-94		
16,339.70	Postage Expenses	37,414.90		3,74,151.00	Collections	1,80,042.75	
48,415.75	Printing & Stationery	40,482.90		59,653.00	Nature Education	61,957.25	
12,308.00	Advertisements	30,058.00		8,000.00	Building maintenance	8,000.00	
57,605.90	Telephone Expenses	70,795.90		4,000.00	Journal printing	1,01,200.00	
41,433.20	Electricity Expenses	78,773.52		Nil	For Renovation of Building	Nil	
13,194.00	Electrical Repairs	4,084.90		52,54,372.71	Other Grants As per Schedule 'C'	61,85,839.89	
56,319.76	Travelling Expenses	5,785.50			(To the extent utilised		
25,222.10	Conveyance Expenses	22,733.00			during the year)		
61,541.50	Vehicle Maintenance	77,951.49			Unspent surplus allowed to be		
6,477.50	Bank Charges (Net)	2,985.80		Nil	retained (Net)	1,45,820.36	
2,000.00	Audit Fees	2,000.00		57,00,176.71			66,82,860.25
20,67,167.46	Carried over	36,06,623.61	16,617.00		Carried over		85,08,897.03

Previous year 1992-93	EXPENDITURE	Current year	Previous Year 1993-94	1992-93	INCOME	Current Year	1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
20,67,167.46	Brought over	36,06,623.61	16,617.00		Brouth over		85,08,897.03
Nil	Xerox Servicing (Charges)	24,036.25					
42,972.30	Repairs and maintenance to Furniture & Equipment	54,399.00					
4,219.00	Insurance other than building	6,685.00					
40,200.00	Professional & Legal Fees	12,250.00			**SUBSCRIPTIONS**		
31,869.54	Loss on surrender of Units of UTI	Nil			Ordinary Members		
4,592.95	Exchange fluctuation	Nil		1,61,610.99	Individuals	2,99,584.61	
45,000.00	Computer maintenance and stationery	15,351.00		7,300.00	Family	510.00	
				11,940.00	Students	23,085.00	
22,36,021.25			37,19,344.86	11,300.00	Corporate Memberships	47,038.00	
				1,40,330.00	Life Memberships (Individual)	1,60,189.96	
				10,000.00	Life Memberships (Corporate)	Nil	
	MISCELLANEOUS EXPENSES			40,207.00	Journal - Members	66,071.43	
				60,990.55	Journal - Non-Members	65,034.00	
8,748.00	Garden Maintenance Exps.	3,925.00		28,409.00	Entrance Fees	35,749.01	
9,050.00	Beautification of Dr. Sálim Ali Chowk	387.00					
24,195.00	General Expenses	25,217.79		4,72,087.54			6,97,262.01
9,212.35	Goregaon Plot Expenses - Salaries, etc.	Nil					
					INCOME		
Nil	Aquarium Maintenance	1,076.00		2,32,218.44	From BNHS Publications (Net)	4,20,886.69	
				6,694.36	From Govt. Publications	1,05,443.56	
51,205.35			30,605.79	66,453.79	From Greeting cards	4,53,748.04	
				14,982.09	From Calendars	1,82,619.46	
	DEPRECIATION			662.90	From BNHS Caps	2,495.00	
				591.30	From BNHS Mugs	49.50	
2,76,348.69	On Vehicles, Furniture and Equipments		4,61,859.12	200.00	From Old Paintings Photographs	21,800.00	
				171.46	From T-Shirts	235.00	
				Nil	From Bags	294.00	
				Nil	From Stickers	126.75	
				3,21,974.34			11,87,698.00
	Carried over		42,28,426.77		Carried over		1,03,93,857.04

Previous year 1992-93	EXPENDITURE		Current year 1993-94	Previous Year 1992-93	INCOME		Current Year 1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	Brought over		42,28,426.77		Brought over		1,03,93,857.04
	AMOUNTS TRANSFERRED TO FUNDS				**OTHER RECEIPTS**		
	AGAINST INCOME			Nil	Foreign Exchange Fluctuation	2,908.04	
	Specific Purpose Donations			13,186.01	Miscellaneous Receipts	7,555.65	
22,896.00	as per Contra	2,30,600.00		68,780.30	Surplus/loss on Members' Camps	Nil	
1,40,330.00	Life Membership Fees Fund	1,60,189.96			Royalty on Dr. Salim Ali's		
10,000.00	Corporate Life Membership	Nil		1,52,935.91	Publications	32,190.91	
	BNHS Publication Fund			3,263.00	Interest on Loan to staff	4,212.00	
	50% Royalty on Dr.Salim			16,073.00	S.Credit balance W/Off	Nil	
76,467.95	Ali's Publications	16,095.45		6,433.50	Surplus from Publications	Nil	
6,694.36	Govt. Publication Fund	1,312.14		Nil	Post Graduate Dept. of Bombay Univ.	1,150.00	
3,263.00	Interest on loan to staff	4,212.00		Nil	Surplus on Seminar (Net)		
5,13,703.50	Fixed Asset Funds	2,30,532.78			GEF 23,210.20		
2,83,188.24	Interest allocation to Funds	2,83,953.95			Elephant 1,43,851.26		
11,014.20	General Reserve Fund	Nil				1,67,061.46	
21,453.38	Salim Ali Memorial Fund	Nil		Nil	Profit on sale of vehicles	2,30,532.78	
5,113.49	Salim Ali Nature Conservation Fund	Nil		Nil	Advertisement for Hornbill	4,000.00	
9,714.80	Salim Ali Investment Revenue a/c.	Nil		2,60,671.72			4,49,610.84
Nil	Nature Education Scheme for 1993-94	61,957.25			**ADMINISTRATIVE FEES**		
11,03,838.92			9,88,853.53	5,66,660.73	For Project Funds	5,80,093.35	
	APPROPRIATIONS TO FUNDS			1,505.64	For Govt. Publication Funds	1,312.14	
	OUT OF SURPLUS			29,155.33	For Other Funds	4,71,520.70	
1,00,000.00	Staff Welfare Fund	1,00,000.00					
2,50,000.00	Staff Gratuity Fund	2,00,000.00		5,97,321.70			10,52,926.19
50,000.00	General Reserve Fund	2,00,000.00					
1,00,000.00	Publication Fund	50,000.00					
Nil	Proposed Institution Fund	5,00,000.00					
Nil	Sálim Ali Memorial Fund	2,00,000.00					
5,00,000.00			12,50,000.00				
	Carried over		64,67,280.30		Carried over		1,18,96,394.07

Previous year 1992-93	EXPENDITURE		Current year 1993-94	Previous Year 1992-93	INCOME		Current Year 1993-94
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	Brought over		64,67,280.30		Brought over		1,18,96,394.07
	EXPENDITURE ON THE						
	OBJECTS OF THE TRUST				**AMOUNTS DRAWN FROM FUNDS**		
	Expenses met out of funds			12,231.08	For Natural History Studies	39,248.12	
1,49,545.76	as per Schedule 'B'	1,94,371.87		1,31,742.51	For Nature Conservation	1,52,100.25	
	Expenses met out of Grants			2,237.27	For Other Educational Exps	3,023.50	
47,09,446.34	as per Schedule 'C'	61,85,839.89		6,346.00	For Gratuity Payment	11,07,896.00	
2,85,950.35	Journal Printing & Postage	4,29,013.20		2,76,348.69	For Depreciation	4,61,859.12	
1,94,217.30	Hornbill Printing & Postage	1,29,531.74			For Beautification of		
25,171.75	Nature Education	10,740.20		9,050.00	Dr Salim Ali Chowk	387.00	
38,037.70	Members activities	62,769.55		1,101.60	For Hornbill Printing	Nil	
	Library Books, Books binding,				(M.Y. Ghorpade Fund)		
33,465.40	Subscriptions & Contingencies	20,855.10		2,233.30	For Nature Education Camp	Nil	
	Reference Collection						
Nil	Maintenance Exp.	1,33,433.43			(Dorabji Tata Trust Fund)		
628.00	Post Graduate Studies	274.75		9,212.35	For Goregaon Plot expenses		
Nil	Laboratory expenses & contingencies	296.90			(Proposed Institute Fund)	Nil	
54,36,462.60			71,67,126.63	4,50,502.80			17,64,513.99
	BALANCE OF SURPLUS						
37,722.90	**CARRIED FORWARD**		26,501.13				
96,62,338.71	TOTAL RS.		1,36,60,908.06	96,62,771.63	TOTAL RS.		1,36,60,908.06

BOMBAY NATURAL HISTORY SOCIETY

AS PER OUR REPORT OF EVEN DATE

Sd/-
HONORARY SECRETARY

Sd/-
HONORARY TREASURER

Sd/-
HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

Bombay,
12th September, 1994.

BOMBAY NATURAL HISTORY SOCIETY
NATURE EDUCATION SCHEME

RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31-3-1994

Previous year 1992-93	RECEIPTS	Current Year 1993-94	Previous Year 1992-93	PAYMENTS	Current Year 1993-94
Rs.		Rs.	Rs.		Rs.
	To Opening balance In Current Account With		1,02,966.87	By Opening Balance	1,62,386.62
1,200.99	ANZ Grindlays Bank p.l.c.	1,200.99	56,653.00	By Salaries To Nature Education Organiser	47,924.00
-	To Grant - Govt of Maharashtra	61,957.25	3,000.00	By Contingency Expenses	3,000.00
233.25	To Sale of Nature Education Booklets	Nil	Nil	By Bank Charges	500.00
1,62,386.62	To Closing balance	1,51,353.37	1,200.99	By Closing Balance in Current Account with ANZ Grindlays Bank p.l.c.	700.99
1,63,820.86		2,14,511.61	1,63,820.86		2,14,511.61

BOMBAY NATURAL HISTORY SOCIETY

AS PER OUR REPORT OF EVEN DATE

Sd/-
HONORARY SECRETARY

Sd/-
HONORARY TREASURER

Sd/-
HABIB AND COMPNAY
CHARTERED ACCOUNTANTS
BOMBAY

Bombay,
12th September, 1994.

BOMBAY NATURAL HISTORY SOCIETY

Annual General Meeting held on 15th September, 1994

The Annual General Meeting of the Society held on 15.9.1994 at 6.30 P.M. when the following members were present:

Mr. Rokad Zubair, Dr. Virinder Singh, Mr. humayun Abdulali, Dr. A.S. Kothari, Mr. K.P. Karamchandani, Mr. R.G. Deshmukh, Dr. Pratap Saraiya, Dr. Shashi Menon, Mr. K.K. Vajifdar, Mr. T.R. Munsief, Dr. Rajendra Shinde, Mr. Ulhas Rane, Ms. Ashraf I. Macchivalla, Mr. S.M. Kalim, Mr. S. Asad Akhtar, Mr. M.G. Rao, Mr. Shashank Ranjit, Mr. J.P. Irani, Mr. Gopal Bodhe, Mr. Sunil R. Zaveri, Ms. Namita Sankhe, Mr. R.V. Bhatardkar, Mr. Deepak Apte, Mr. Ulhas Paralkar, Mr. A.S. Parab, Dr. B.F. Chhapgar, Mr. G.L. Kalro, Mr. S.L. Chullani, Mr. Sam Bhacka, Mr. C.F. Gursahani, Ms. S.K. Vajifdar, Mr. Mihir Devare, Mr.D.P. Bamuniya, Ms. Deepika Bhardwaj, Mr. Prajakti Satish, Mr. Bansi Mehta, Mr. U. Deshmukh, Mr. Sachin Kulkarni, Dr. Nitin Kumar, Mr. Pratap M., Mr. Rishad Naoroji, Mr. Anish Kapadia, Mr. Meghnad Kulkarni, Mr. C.B. Mehta, Mr. K.G. Nayak, Mr. G.S. Ranganathan, Mr. Pervez Cama, Mr. D.S. Gogate, Mr. D.W. Smith, Mr. T.S. Chandran, Lt. Kanwar Bir Singh, Mr. C.N. Chandrasekhar, Mr. S. Chandrashekaran, Mr. Nitin Jamdar, Mr. N.D. Mulla, Mr. Bittu Sahgal, Mr. Bhushan V. Samant, Mr. Ravi Mahimkar, Ms. V. Shubhlaxmi, Mr. Suresh Sawant, Ms. Kini, Mr. Leon Lobo, Mr. D.C. Balsara, Mr. Manoj J. Karkhanis, Mr. H.S. Gala, Mr. Suresh G. Bhatkal, Mr. S. Kala, Mr. K.R. Shah, Mr. P.H. Mistry, Dr. A.M. Bhagwat, Mr. D.V. Golalkar, Mr. S.G. Vakil, Ms. D.S. Variava, Mr. Amal S. Mehta, Ms. Khaira Vakil, Ms. Vidya Athreya, Mr. Ramana Athreya, Mr. T.V. Jose, Mr N.O. Parikh, Mr. N.S. Dalal, Ms. Hema Somnathan, Mr. M.J. Fernandes, Mr. Eustace Alexandra, Ms. Jayshree Sethna, Mr.B. Pimento, Mr. Manoj Gupta, Dr. A. Karim M. Naik, Mr Arvind Kumar Shinde, Mr. M. Bharucha, Ms. Mehra Dubhash, Mr. S.D. Bhaumik, Mr. Kiran Srivastava, Ms. Doreen D'sa.

Earlier Mr. Humayun Abdulali, was felicitated. He also completes 50 years of active service to the BNHS. The EC also took this opportunity to felicitate its major donors during 1993-94. this programme was followed by High Tea. The AGM then started at 6.30 p.m.

The President, Mr. B.G. Deshmukh welcomed the members and said that, "You must have seen that the membership is on the increase but not at the rate at which we will like it to be. We are taking extra measures to increase membership by arranging visits and talks at various schools and colleges to begin with in and around Bombay. We are also planning to extend this activity to places outside Bombay. I would request all the members that they may kindly find time to help the Society in enrolling more members."

He further observed that, "I would also like to state that the membership outside Bombay should increase in counter some sort of propaganda being made that the BNHS is not an all India Society but only a Bombay Society.

If you see our membership form, we have got members not only from India but also from abroad. There were also suggestions to change the name of the Society. However, it would not be desirable. Commenting on the financial positions of the society, he stated that, "we had to withdraw Rs 18 lakhs from our own funds to meet the necessary expenditure." He also informed that the Society was giving due attention to the conservation issues and had identified such issues, to get their scientific study made, to organize technical seminars and then public debates; and also to approach the Governments. Dr. Pratap Saraiya, chairman, Salim Ali Nature Conservation Fund, explained the action they had taken regarding the same.

The minutes of the Annual General Meeting held on 5th November 1993 were taken for confirmation.

The President requested Honorary Secretary to inform members about action taken on these minutes.

The Honorary Secretary reported:

Regarding conservation issues, he informed that action had been initiated as per suggestions that the BNHS should become a Nodal Agency and should invite and interact with people and come out with some plans which could be put forward to the Governments so that these issues could be tackled. We had made attempts to gather information from the members and organisations regarding different conservation issues. Some members have responded to our letters by suggesting specific areas that need immediate attention. On that basis we had a meeting on 8th September 1994, Dr. Saraiya was Chairman of the meeting and a large number of NGOs and members interacted so as to come out with a specific plan, Hon. Secretary requested Dr. Saraiya to give details of the meeting, Dr. Saraiya briefed the house about conservation issues. He also informed the members that our plan was to have some selected issues which could serve as model. In the meeting two issues were selected, one was denotification of sanctuaries. They also had discussions about how the BNHS can participate in it actively.

Mr Virinder Singh demanded that the Society should pass a resolution condemning a series of denotification which have taken place.

Honorary Secretary, informed the house that the President has personally written letters to Gujarat Government regarding the problems of the denotification of the areas in Gujarat state specifically. Letters had also been sent regarding the Melghat Tiger Reserve.

Some of the members suggested that before passing a resolution, the issue requires proper discussion wherein all members can participate.

The President assured that we can certainly pass a resolution. However, it would be better if a special meeting is called for the same.

Mr. Bittu Sahgal pointed out that inspite of not being on the Agenda, a resolution worded simply that the recent actions of the Governments for denotification be condemned and we ask for a moratorium on all the denotifications until such time as the nation had opportunity to debate and the value of these resourts established.

He suggested that the AGM accept a resolution, word it categorically, but not necessarily against one particular Government. The BNHS members then can discuss the matter but there should be a general body mandate. President suggested that this point deserves proper discussion, if the House so desires.

Regarding health status of collections staff, the HS informed that collections staff were sent to Dr Kothari for medical check up. Reports have been received and follow up actions have also been taken. Staff has been sent to the specialist for further treatment. The Society has agreed to bear all the expenditure incurred for such treatment.

A query was raised by Mr Parvez Cama that how this took one year. HS answered that it was initiated almost 8 months ago, it took long time for medical professionals to give their report. They had the staff screened twice because they could not come to any definite conclusion and as a result the final reports came only about two months ago and after that the remedial actions have been taken.

Minutes were accepted as proposed by Mr. Karamchandani and seconded by Dr A M Naik.

Item II.

Annual Report of the Ex-Committee for the year 1994

The HS gave information regarding the status of projects which are in the pipeline and then the report was discussed. The President informed the Committee that our research staff is doing excellent work. Mr Ulhas Rane proposed and Mr. Chandrasekhar seconded that the report be adopted. It was so adopted.

Item III.

The Balance sheet and Statement of Accounts for the year 1993-94 were taken up for consideration.

The Honorary Treasurer (HT) explained the current accounting procedures.

One of the members wished to know the position as to how the Society is going to recover government grants and what are the efforts made for Nature Environment courses for Army. The Society has already incurred an expenditure of Rs. 45,587/-. However, as the Army has a provision to spend money on such courses, Society need not have spent any money.

In reply, to this query, HT informed that (1) regarding grants to be received from the government, arrears have gone up to Rs 4,80,000/- and (2) we have been allotted one Charity Race on this behalf for maintenance of collections and we have received a sanction letter for R. 8,52,000/-. The grant for air-condition has yet to come. Regarding money which has to come from Army, we have a sanction of Rs. 1,00,000/-. Mr. Bittu Sahgal observed that the collection of administrative fees is lower; he also felt that members should have got the report 3 weeks before the AGM.

HT advised that the copies of balance sheet were available 7 days in advance. Regarding administrative fees, he stated that it has increased from Rs. 5,97,000/- to Rs. 10,52,000/-. President also explained the difficulties in increasing the income and also requested members to give their suggestions as to how to generate funds to run the Society.

Mr Nitin Jamdar expressed concern about not getting the copy of balance sheet in time. HT advised that there were certain government conditions which made us change certain figures and due to that report was delayed.

Mr. Bittu Sahgal raised the point that scientific staff is not a burden on the Society and Society should look after them properly. He suggested that numbers should be put on the pages of annual report so that it would be easy for members to refer it.

Regarding project and other accounts, his query was why we cannot put it in one account. The HT answered that it is as per rules and if any member would like to take a look at the breakup it can be shown.

Mrs Variava explained in detail the financial position (past and present) of the Society. She also expressed her ideas about the working of the Product Section and requested members in come up with suggestions and new ideas for Product Section of the BNHS.

The HT appreciated that during the year income from the products had been very good but expressed concern about non-availability of greeting cards for Diwali Season.

Mrs Variava informed that they had some problem regarding the catalogue, design, etc. but this is getting sorted out.

To a query by a member as to how we contacted companies for sale, Mrs Variava explained that they are being contacted by telephone and also requested members to help the Society by introducing hardworking persons for the Product Section. The member inquired whether any Professional Management Consultant has been appointed for Product Section, Mrs Variava said she is looking into it.

Dr. Shashi Menon expressed his feelings on the remark of some members that the BNHS is not giving support in scientific staff. He said that all scientists are on contract and so they should write project proposals well in advance so by the time their ongoing project gets over, new project comes in, he further said that Society should realise that unless we give good and attractive salary to the scientists they would not accept our offer, Mr. S Kala wished to know the increase in expenditure of staff. The HT informed that since Government has refused to give funds for our staff, and this has to be borne by the Society. On a query regarding group gratuity scheme, HT informed that keeping the interest of our staff in mind, our own gratuity scheme has been provided through externally funded LIC group gratuity scheme and for this we have paid Rs 9,35,000/- which includes Rs 98,000/- for past services rendered. Scientific and other staff have been covered.

President was confident that the Society will come out of these financial difficulties.

Dr Pratap Saraiya raised a question regarding increase in income because of product and publications. He wished to know how much is the increase due to publications and products. The HT gave him a detailed reply, Mr N D Mulla appreciated that annual report and balance sheet have come out well. He raised a question that some years back we had got grants from government for publications and who is responsible for not getting them this year.

The HT advised that for these publications we received grant 5 years back. We hope that this year, we will be able to publish 4 or 5 booklets out of 36 of NCSTC Series. Regarding Mr Sahni's book, the matter is being pursued vigorously and by this year we should be able to have a draft copy ready.

The HS informed that NCSTC work is being coordinated together by Mr Daniel and Mr Bittu Sahgal.

While explaining the situation, Mr. Bittu Sahgal stated that there is a fault in the system and he would like Publication Sub-Committee of BNHS to give him some freedom to choose the authors and articles to enable him to complete the work as soon as possible. While commenting on Mr. Bittu Sahgal's remarks. President stated that he was given powers 3 years back to select authors for the Series. He also informed that it has been decided in a recent EC meeting to withdraw this project from Mr. Bittu Sahgal.

Mr. Humayun Abdulali asked about index for the journal and publication of his articles and said that at least the work of indexing of the Journal should be done as early as possible. He raised the point that at the last AGM members were told that computerisation of indexing is being done. He wished to know how enlighten the House on this point. Since Dr. Chhapgar was not aware of this, President requested HS to find out the situation and mention it in the next Journal and make members aware of that.

Mr. Rishad Naoroji raised a point about huge backlog of ornithological papers received for publications. The President informed that the matter will be referred to the Publications Sub-Committee to explore the possibility for bringing out a supplement of the Journal to clear the backlog.

Dr Abdul Karim suggested that HS should make an appeal in his monthly circular and ask every member how much money, energy and time each one can devote for the job at the Society and their ideas and suggestions should be noted and made best use of.

Mr. Anish Kapadia suggested that we can and should approach the organisations like ICICI, etc. for funding and should not think about their nature.

Dr (Ms) Saikia pointed out that there are some members at Pune who are interested in doing research and other activities for the BNHS and would it be possible for the BNHS to open a branch at Pune. President advised that this point has been noted in the meeting held at Pune in the past and would be looked into.

Mr Naik proposed and Mr Chandrahas seconded the report be adopted. It was so adopted.

Item IV

Appointed of Auditors for the year 1994-95

It was resolved that M/s Habib and Company, Chartered Accountants, Bombay 400 023, be reappointed as the Auditors for the Society for the year 1.4.1994 to 31.3.1995 on a total remuneration of Rs 5,000/- (Rupees five thousand only).

Item V

President read out some resolutions received from the members regarding the Conservation Education Project at Goregaon and denotification of sanctuaries.

Mr Safal Kumar Mishra suggested to revive the practice of giving reprints, the minimum order for this and how much should be charged. This can be decided by the Publications Sub-Committee. This point was noted.

Mr Suresh Sawant suggested/informed that he and other members had approached the Filmcity personnel to stop environmental damage. They were told that the BNHS itself is damaging the same by constructing the Centre. He would like the BHNS to stop the work and save the environment.

The HS advised that construction work is going on our land and not in the National Park. This land was given to us by the Government of Maharashtra and the Centre is being built for the cause of nature conservation only. On request made by the HS, Mr Rane informed that our land is not a part of the National Park, Centre is being built on an area of 710 sq. m when our land is 33 acres, and the remaining area will be maintained green. He also said that whoever wants to see the land can come and satisfy himself.

Dr Virinder Singh requested that the correspondence between the Forest Department and the BNHS about the legal position of the land be shown to members and make members aware of the construction activities.

Dr. Shashi Menon informed that we got the Conservation Education Project only because we had land. The BNHS could not do anything on the land during these 10 years period because of lack of funds.

A member asked if before commencing this project we have done any environmental audit, etc. President answered that it was a barren land and it was members who helped us a lot in making the land green. He also informed that HS had circulated the detailed information about all this in his monthly circular.

Mr Nitin Jamdar informed that when he and other members wanted to go to the land, they were asked by the National Park personnel to enter from outside, i.e. from the film city area. He wished to know the exact situation and expect the BNHS to keep them informed.

Mrs Variava shared some thoughts on this matter. Her concern was that since we are doing good work, we should tackle the problems and go ahead.

Mr Beharamfram expressed that we should complete the work as early as possible before some other lobby comes and grabs it from us.

President also requested members to visit the land, go through the papers and satisfy themselves and help the Society in tackling the problem.

Mr Anish Kapadia expressed that Society should do its best, solve the problem and go ahead with its work.

Mr Banerjee suggested that members should have a meeting to understand the BNHS' stand. Clear understanding between BNHS-EC and members would help in solving the problem.

President assured members, that we will arrange a workshop to discuss in detail some of these important issues. One is how to preserve the BNHS's reputation in conservation matters; and without compromising the basic objective, how it can restructure its finances, get projects and how to build up a pool of good scientists and how to retain them.

Mr Bittu Sahgal raised question regarding airconditioning grant which is outstanding to the tune of Rs 15 lakhs. The concern was to maintain the collections. He saw fungus on the walls. It would not take much time for it to go on the specimens. He suggested either to keep the windows open or to give explanation for what is being done. Mr Sunil Zaveri explained the position in detail and invited members to visit the collection and see for themselves.

Mrs Variava proposed an amendment to the resolution that the construction of the Centre should be done, provided it is not within the National Park.

Mrs Mehra Dubhash stated that last year when a function held, and the Governor had come to lay the foundation stone, everyone was present. So everyone is quite aware of the activities and now there is no point in discussing the same thing again and again.

There was a suggestion that there is harassment from the forest department to the members when they go for bird watching. President advised that this point has been noted and the matter is being looked into. We are hopeful to get good results after discussing the same with foreset officials. Suggestions were made by Mr Suresh Sawant and Mr Pardiwala to review and analyze camp charges properly. President advised them that they can sit in the office and go through the charging method. Dr Shashi Menon wondered whether other organisations can arrange camps for the BNHS. A decision can be taken in this AGM only.

Suggestions made by Lt. Gen. Baljit Singh regarding series of denotification in various areas. President advised that he will have the matter looked into.

Mr Nitin Jamdar suggested that the resolution be passed by the BNHS and to do it as soon as possible.

Dr Pratap Saraiya expressed concern that any resolution passed by the BNHS should be exact and accurate and we should be careful about it.

Mr Virinder Singh expressed his views regarding the same.

Mrs Variava had detailed discussions with the members on this matter. Members of the BNHS have recorded their serious concern about any denotificaions or proposed denotifications of National Parks and Sanctuaries without adequate assessment of the ecological value of the areas being denotified and without adequate public disclosure and debates. No resolution was moved.

Mr Parvez Cama enquired about books reported lost from the Library and success in recovering them. The HS informed that it was not very encouraging. Mr. Cama complimented the Society for using alternative material instead of wood for construction of doors.

Mr N D Mulla complimented the Honorary Treasurer for completing the auditing of accounts in time and calling the meeting within 7 days of completion of auditing.

Mr Bibhas Amonkar inquired about release of Bird-call cassettes which were pending since last 10 years. Dr Saraiya informed that master cassette is being prepared by Dr Bharucha as this work was entrusted to him in 1983.

Mrs D S Variava proposed the vote of thanks, and the AGM then terminated.

THE SOCIETY'S PUBLICATIONS

The Book of Indian Animals, by S.H. Prater, 4th edition (Reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations. *(Price to members Rs.* 170)

The Book of Indian Birds, by Sálim Ali, 11th (revised) edition (Reprint). 74 coloured and many monochrome plates. *(Price to members Rs.* 150)

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Checklist of the Birds of Delhi, Agra and Bharatpur, by Humayun Abdulali & J.D. Panday*Rs.* 3

The Book of Indian Reptiles, by J.C. Daniel *(Price to members Rs.* 162*)*

Some Beautiful Indian Trees, by E. Blatter and W. Millard. With many coloured and monochrome plates. 3rd edition (Reprint). *(Price to members Rs.* 160*)*

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Encyclopedia of Indian Natural History, Edited by R.E. Hawkins *(Price to members Rs.* 225*)*

A Century of Natural History, Edited by J.C. Daniel *(Price to members Rs.* 160*)*

Conservation in Developing Countries: Problems and Prospects, Edited by J.C. Daniel and J.S. Serrao *(Price to members Rs.* 300*)*

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TERRITORIAL DISPLAYS OF THE BENGAL FLORICAN[1]

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(*With four text-figures*)

Key words: Bengal florican, bustards, displays, triggers, stimuli

I studied the territorial displays of male Bengal florican *Houbaropsis bengalensis* to understand why their displays are often triggered by calls of unrelated species. Only three of 14 males were within acoustic range of each other. The closest of males were at distances that varied from 0.35 km to 2.25 km (mean 1.2 km, SD 0.67 km, n=14). Males performed two types of territorial displays. The first was by erecting the plumes on the neck and head, and the second territorial display was an exaggerated flight. The flight display was accompanied by auditory signals. Unique to the flight display was a loud clapping sound produced by the wings. There was greater propensity of males within acoustic range of another to display soon after a neighbour displayed. Displays of Bengal floricans were also triggered by calls of other species of birds, chiefly peafowl *Pavo cristatus*, and the jungle crow *Corvus macrorhynchos*. Of 611 display flights recorded, 66% immediately followed such calls. Displays by Bengal floricans were occasionally triggered by other sounds. Calls of the Indian pied hornbill *Anthracoceros malabaricus*, red wattled lapwing *Vanellus indicus*, and on one occasion a gunshot, triggered display.

INTRODUCTION

Territorial displays in the bustards, Otididae, are as spectacular as they are diverse, and can be broadly classified into four categories (Osborne *et al.* 1984). The 'balloon' type display is seen amongst the heaviest members of this group and is the prevalent form of display in the genera *Ardeotis, Neotis* and *Otis* (Mattingley 1929, Cramp and Simmons 1980, Osborne *et al.* 1984, Hellmich 1988; Rahmani 1989). The second is the running type of display, which is seen in the houbara bustard *Chlamydotis undulata* (Mendelssohn *et al.* 1979). The third and fourth categories are both aerial displays and are performed by the smaller members of the bustard group. One of these is a display leap or jump as is seen in the little bustard *Tetrax tetrax* (Schulz 1985) and the lesser florican *Sypheotides indica* (Dharmakumarsinhji 1950, Ridley *et al.* 1985, Sankaran 1991). The other is an aerial display flight and is seen in African bustards such as the black-bellied *Eupodotis melanogaster*, buff crested *E. ruficrista* and black bustards *E. afra* (Osborne *et al.* 1984) and in the Bengal florican (Narayan and Rosalind 1988, Narayan 1990, Sankaran 1991).

Based on their territorial displays, polygynous bustards can be categorized into three types. Species that display on the ground, those that have a jumping display and those whose territorial displays are exaggerated flights. The species that perform jumping displays are the smallest (wing length < 250 mm), those that have flight displays are medium sized (265-350 mm) while those that have ground displays

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are the largest (390-761 mm). The Bengal florican and the black-bellied bustard (342 and 346 mm respectively) appear to be at the size threshold above which all species have only ground displays (Sankaran 1991; source of wing measurements: Cramp and Simmons 1980, Ali and Ripley 1983, Collar *et al.* 1986). These two species are of considerable interest because both have ground displays and aerial displays (this study; Cramp and Simmons 1980).

In the study reported here, I quantitatively describe the territorial displays of male Bengal florican with reference to the kinds of displays performed, frequency of performance by and variation between individuals, temporal distribution of displays and the influence of displays by one male on another. I then examine in detail a fascinating aspect of male Bengal florican behaviour; the phenomenon of calls of unrelated species, for example the peafowl *Pavo cristatus* and the jungle crow *Corvus macrorhynchos,* triggering territorial displays of this species.

MATERIALS AND METHODS

Study Area: I studied the Bengal florican at four separate grassland sites within the Dudhwa Tiger Reserve (area 815 sq. km), in the northern extremity of Lakhimpur Kheri district of Uttar Pradesh, India (28° 24' and 28° 40' N and 80° 34' and 80° 50' E). The study area lies in the western extremity of the range of the Bengal florican, and differs from areas further east in being relatively drier (cf. Narayan 1990).

The wet alluvial grasslands (*terai*) that comprised my study area were characterised by a few dispersed trees and a distinct mosaic of grass communities. 'High ground' areas were not subject to inundation during the monsoons and were dominated by shorter grass species like *Imperata cylindrica* and *Desmostachya bipinnata.* 'Low ground' areas, which tended to be inundated during the rains were dominated by taller grasses such as *Schlerostachya fusca, Saccharum spontaneum* and *Erianthus munja.* Those areas where water was retained for prolonged periods were characterised by grasses like *Phragmites karka* and *Arundo donax.* The tree cover in the grasslands was sparse; predominantly *Acacia catechu, Dalbergia sissoo* and *Bombax ceiba.* These grasslands bordered dense *Shorea robusta* forests.

The four grassland sites studied varied in area, the sizes being 62, 85, 120 and >250 hectares. The former three had one territorial male each, while the last had three. I named the 5 males studied according to the grassland they occupied. *Kowaghatti, Navalkhad* and *Chapra* (abbreviated accordingly in this paper) were solitary males while *Seethagadaia* East and West were males that were within acoustic range of each other.

Study Animal: The Bengal florican is one of the world's rarest bustards (Osborne *et al.* 1984) and the current world population is estimated at 400 birds (Rahmani *et al.* 1991). It is a large bird (adult males weigh about 1.5 kg), and occupies a monotypic genus in the family Otididae (Osborne *et al.* 1984). This species is promiscuous and exhibits a dispersed lek mating system (Sankaran 1991). In my study area, the breeding season commences in the first week of March and ends at the end of June coinciding with the onset of the monsoon, during which period males occupy territories (briefly described below) that are fiercely defended from other males (Sankaran 1991).

Females did not associate with males, except very briefly. Thus a male performed territorial displays in the absence of females and, in most cases, other males. A distinct pre-copulatory display is performed by males when a female approaches it. Circumstantial evidence showed that parental care is only by the females.

Methods: The study period covered 341 days between 1987 and 1989; from 30 April to 6 June 1987, 22 January to 22 June in 1988, and 15 February to 15 July in 1989.

As males occupied disjunct territories, *machans* (platform) were built on suitable trees in or adjacent to the territories of the males under study. I carried out observations from the *machan* from day break until the bird left the display area. I resumed observations about 4 hours before sunset and watched the male from when it returned to its display area until it roosted at dusk. Over a period of 10 days, males of each grassland site were observed for the morning and evening on two days.

Observations conformed mainly to the focal animal sampling method (Altmann 1974). The males were observed continuously with a spotting scope and changes in activity (e.g. foraging, standing, preening, display, etc.) were noted to the nearest second.

As peacock calls were the primary triggers of display, the frequency of peacock calls were noted. This followed two methods. Initially I noted down the occurrence of the peacock calls to the nearest second, and its effect on the Bengal florican. Subsequently the number of peacock calls that were heard over every half an hour period were recorded. The timelag between a peacock call and display of a florican was recorded using a stopwatch, the time being measured from the end of the call to the beginning of a display. As peacocks have different calls, the kind of call that triggered display and the presence or absence of triggers each time the Bengal florican performed territorial display were noted. In the case of other sounds which triggered displays (e.g. crow calls), I only noted the type of the trigger.

RESULTS

Territory: The male Bengal florican is territorial, and spacing patterns of territories indicate that the breeding system of this species can be defined as the dispersed lek. The size of male territory varies from 18 to 28 hectares.

Within the territory, a male had a core area from which it displayed; this varied in size between males from 2.1 to 8.4 hectares. Display sites were located in an area of short grass that resulted in males becoming conspicuous as soon as they moved into the 'display area'. All males studied came into their 'display area' about 2.5 to 3 hours before sunset. They roosted at the display sites in the night and left the sites about 3 to 3.5 hours after sunrise. Males generally spent the day in areas of longer grass away from the display sites, but within the territory.

Most males were beyond acoustic or visual range of each other, as the intervening areas were often forested. Of the 14 territorial males that I monitored, 9 were not within acoustic or visual range of another. The distances of the nearest neighbouring males varied between 0.35 km and 2.25 km (mean 1.2 km, SD 0.67 km, n=14). In the grassland which had three territorial males, intra-male distances were between 350 and 400 m.

Types of Display: Males perform two types of territorial displays during the breeding season. The first is a neck fluff display which is achieved by erecting its elongated neck and head plumes, either partly or fully. Partial fluffing of neck feathers resulted in a perceptible thickening of the neck while full fluffing of the neck resulted in the plumes being spread out fully like a fan. The overall mean duration of the neck fluff display was 17 seconds (SD = 32 seconds, n = 679). The mean duration of the full neck fluff was 16 seconds (SD = 32 seconds, n = 482), and that of partial neck fluff was 23 seconds (SD = 16 seconds, n = 197). The full neck fluff display was of a significantly shorter duration than the partial neck fluff display (Mann-Whitney U test, U = 4179, $p < 0.002$).

The second territorial display was an aerial one. This flight display consisted of an initial rise to about 3 to 4 metres followed by a descent and then another rise before the male landed in a dive. The mean duration of flight displays was 6.1 seconds (SD =0.59, n = 64). The distance covered by the display flight varied between 15 and 25 metres. The flight display is accompanied by auditory signals. The one unique to the flight display is a loud clapping sound produced by the wings during the first ascent. This lasts about 1-1.2 seconds and consists of between 12 and 15 individual claps. Once the first peak is reached, the bird then begins vocalizing. This is the 'chik' call, but is not unique to the flight display as it is made during regular flight and threat displays as well. Between 4 and 6 individual 'chik' calls are made during each display flight (mean = 5.49, SD = 0.56, n = 33). About 1 'chik' call is made for every 1.1 seconds of display flight.

Nine percent of flight display can be termed as ‘extended flight displays’ and vary from the normal in that after the first ascent and descent, the male carried on flying and then landed in a display dive (i.e. the second ascent and descent). Or, the display began in the typical manner but did not end in a display dive, or the male began flying normally but landed in a display dive. The average duration of the extended flight display was 16.5 seconds (SD = 7.4, n = 8). Males differed in the frequency of extended flight displays. In two males over 16% of display flights were extended flight displays compared to less than 4% in three others.

The neck fluff display did not always culminate in a flight display. For instance, of 420 territorial displays (both neck fluff and flight) observed in three males, 174 (41%) were neck fluff displays that did not result in the flight display. However, the flight display is preceded by the neck fluff display, the duration of which was variable. The duration of neck fluffing was significantly lower when the fluffing culminated in the flight display than when it did not ($t = -3.406$, $p < 0.001$).

Intensity in territorial display varied. The most passive form was a male advertising its presence by standing in an area of short grass, or on a small mound of sand within its territory and thus becoming very conspicuous. Among active territorial advertisements, the partial neck fluff display was more passive than the full neck fluff display, during which the males were visibly more excited. The most active territorial display was the flight display and it was often a culmination of a series of partial or full neck fluff displays.

Display Periods: Territorial displays are clustered around sunrise and sunset (Fig. 1 a, b). 70% of morning displays occurred within 85 minutes of daybreak and 70% of evening display occurred within 50 minutes to sunset. A peak in number of displays occurred at about 20 minutes after sunrise and 20 minutes before sunset. Only one male out of the five studied showed a preference to display in the mornings (Mann-Whitney U test, $p < 0.01$), the others had no such preference ($p > 0.1$).

The number of display flights performed by males in a display period were few. For almost 25% of observed display periods, males in spite of being present within their territory did not perform flight displays (Table 1). For 80% of display periods, males performed 5 or less flight displays. On an average, males performed between 2.2 and 7.4 display flights per display period (Table 2).

Variation in display rates within the breeding season: The display rates varied considerably between days and even between the morning and evening of a day (Fig. 2 a, b, c). Correspondingly the display rates did not show any consistency between males.

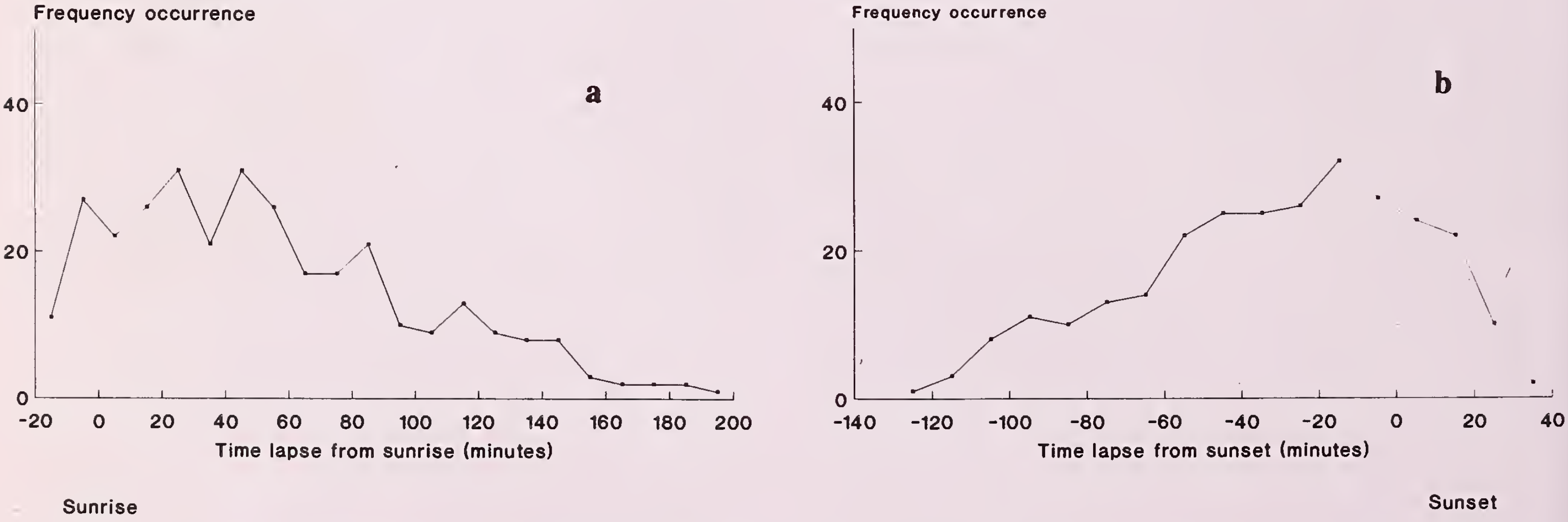


Fig. 1. Distribution of territorial displays of male Bengal floricans during the morning and evening display periods in relation to sunrise (1a) and sunset (1b). Maximum display occurs within a narrow time frame of sunrise and sunset.

TABLE 1

THE NUMBER OF DISPLAY FLIGHTS PERFORMED BY FIVE MALE BENGAL FLORICANS IN A DISPLAY PERIOD. THE FREQUENCY TABLE SHOWS THE NUMBER OF TIMES EACH MALE WAS OBSERVED TO PERFORM 0 TO >9 FLIGHT DISPLAYS DURING A DISPLAY PERIOD. DATA IS FROM 206 DISPLAY PERIODS (BOTH MORNING AND EVENING). (SEE. E., SEE. W., KOW., NAV. & CHAPRA ARE THE IDENTITY OF 5 TERRITORIES

	No. of flight displays performed during a display period											
	0	1	2	3	4	5	6	7	8	9	>9	n.D.P.
See. E.	0	2	1	0	1	0	2	1	2	2	5	16
See. W.	3	1	1	1	4	1	1	2	1	1	0	16
Kow.	12	15	12	11	9	7	4	0	1	1	1	73
Nav.	21	12	9	5	3	7	1	1	1	0	3	63
Chapra	14	8	4	4	0	3	1	2	1	1	0	38
Totals	50	38	27	21	17	18	9	6	6	5	9	206
%	24.3	18.5	13.1	10.2	8.3	8.7	4.4	2.9	2.9	2.4	4.4	

TABLE 2

COMPARISON OF NUMBER OF DISPLAYS PERFORMED PER DISPLAY PERIOD BY FIVE MALES USING MANN-WHITNEY U TEST

	See. E.	See.W.		Kow.		Nav.		Chapra	
		U	p	U	p	U	p	U	p
See. E.		195.5	0.01	171.5	0.01	125.5	0.06	218.5	0.001
See. W.				125.0	0.59	83.0	0.80	169.0	0.12
Kow.						1816.5	0.06	1097	0.07
Nav.								1199.0	0.84
Mean	7.4	4.0		2.8		2.3		2.2	
SD	3.8	2.8		2.5		2.8		2.6	
n D.P.	16	16		73		62		39	

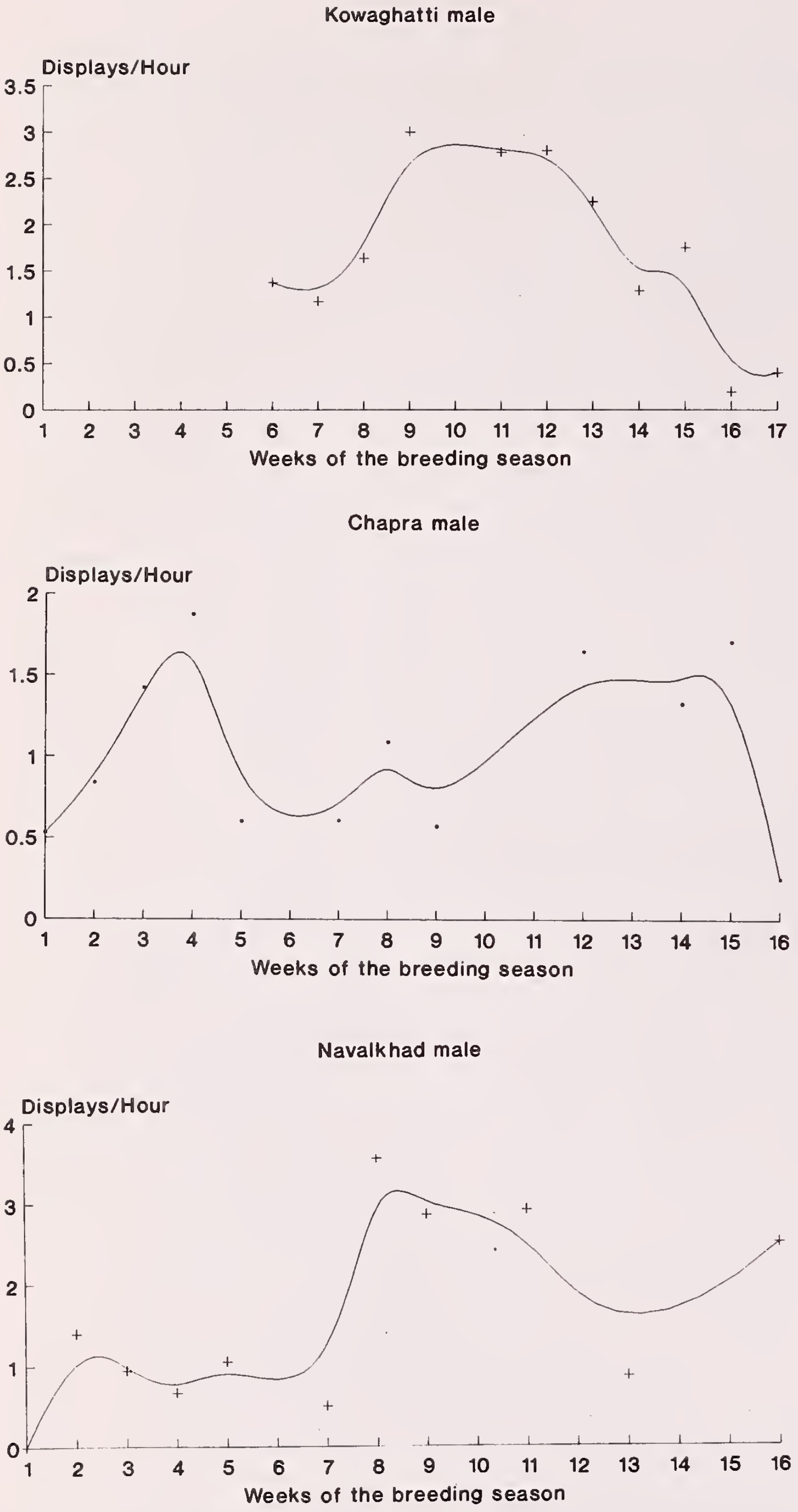
TABLE 3

DIFFERENCES (BY T TEST) IN THE MEAN DURATION OF THE NECK FLUFF DISPLAY THAT WERE TRIGGERED BY CALLS (PEACOCK AND CROWS) AND NOT TRIGGERED BY CALLS

	Neck Fluff followed by flight display					Neck Fluff not followed by flight display				
	WPC		WNT		WCC	WPC		WNT		WCC
	T	P	T	P		T	P	T	P	
WCC	2.433	0.021	-1.214	0.240		1.668	0.103	0.681	0.501	
WNT	2.387	0.028				2.539	0.017			
Mean	0.153		0.263		0.180	0.264		0.448		0.580
SD	0.259		0.241		0.130	0.192		0.301		1.255

Key : WPC = With peacock calls; WCC = With crow calls; WNT = Without sound triggers

A sound was said to have triggered a display when there was no time lag between the end of the sound and the commencement of display, that is, the sound began slightly before males responded by displaying.



Curve-least square fit; Data from 1989

Fig. 2. Variation in weekly display rates of three male Bengal floricans through the breeding season.

Variations in display rates between males: I tested display rates to see whether variations existed between males and whether two males which were within acoustic range of each other had greater display rates than solitary males. Though the display rates of the males that were within acoustic range were higher than the solitary males (Table 2), only one of these males (See. E.) had significantly higher display rate than the others. Even between solitary males differences existed in the number of displays performed during a display period.

Stimuli and Triggers: Of the 14 identified territorial males in the study area, only 3 males were within acoustic range of each other. There was a greater propensity of these three males to display soon after a neighbour displayed. On some occasions (7%) one male responded to another by displaying immediately, that is both were in the air together. More often (27%), males displayed a short time (within 2 minutes) after a rival displayed (Fig. 3).

Displays of Bengal floricans were often triggered by the calls of other species of birds, chiefly peafowl, and to a lesser extent the jungle crow. A sound was said to have triggered a display when there was no time lag between the end of the sound and the commencement of display (0 seconds), that is, the sound began slightly before males responded by displaying.

Of the 611 display flights recorded, 66% immediately followed such calls. Of these, 72% followed peacock calls and 28% followed crow calls.

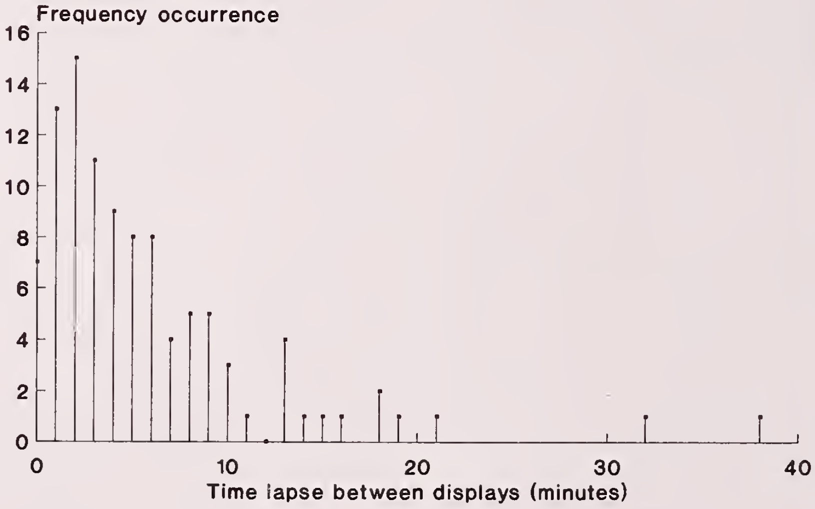


Fig. 3. Time lapse between flight displays of three male Bengal floricans which were within acoustic and visual range of each other. Males tend to display within a narrow time frame of another male's display.

59% of instances of neck fluffing was not followed by flight display (n = 509) were triggered by calls. 87% of these were triggered by peacock calls and 13% by crow calls. Displays by Bengal floricans were occasionally triggered by other sounds. Calls of the Indian pied hornbill *Anthracoceros malabaricus,* red wattled lapwing *Vanellus indicus,* and on one occasion a gunshot, triggered either neck fluffing or flight display.

I measured time lapse between peacock calls and Bengal florican displays. Of the 196 instances when time lapse could be measured between the end of a peacock call and the commencement of a display, 82% of displays occurred while the peacock was calling (Fig. 4). A uniform distribution of displays at all other intervals show that there was no lag effect of peacock calls on the Bengal florican's display, and that the call had an effect for that instance only.

As both peacock calls and Bengal florican displays occur at greatest intensity in a narrow time range, that is, at sunrise or sunset, it was possible that both occurred at identical moments purely due to chance. On testing the data I found that Bengal florican displays had a significantly higher probability of following peacock calls than that expected purely by chance (chi square 277.5, DF 1, $p < 0.0001$).

I examined the effect of the presence and absence of sound triggers on the duration of neck fluff display. I expected to see two patterns. Firstly, if there was a difference in the degree of trigger effect between calls, I expected that the duration of neck fluff display culminating in flight display would be least in those displays triggered by peacock calls. Secondly, because triggers have an instantaneous effect on display, I expected that the duration of neck fluffing will be longest when the neck fluff display occurs independently of triggers.

Correspondingly, I divided neck fluff displays into two: (a) when the flight display followed, and (b) when the flight display did not follow. As expected, when displays were triggered by peacock calls, the duration of neck fluff was significantly lower than in those displays which were triggered

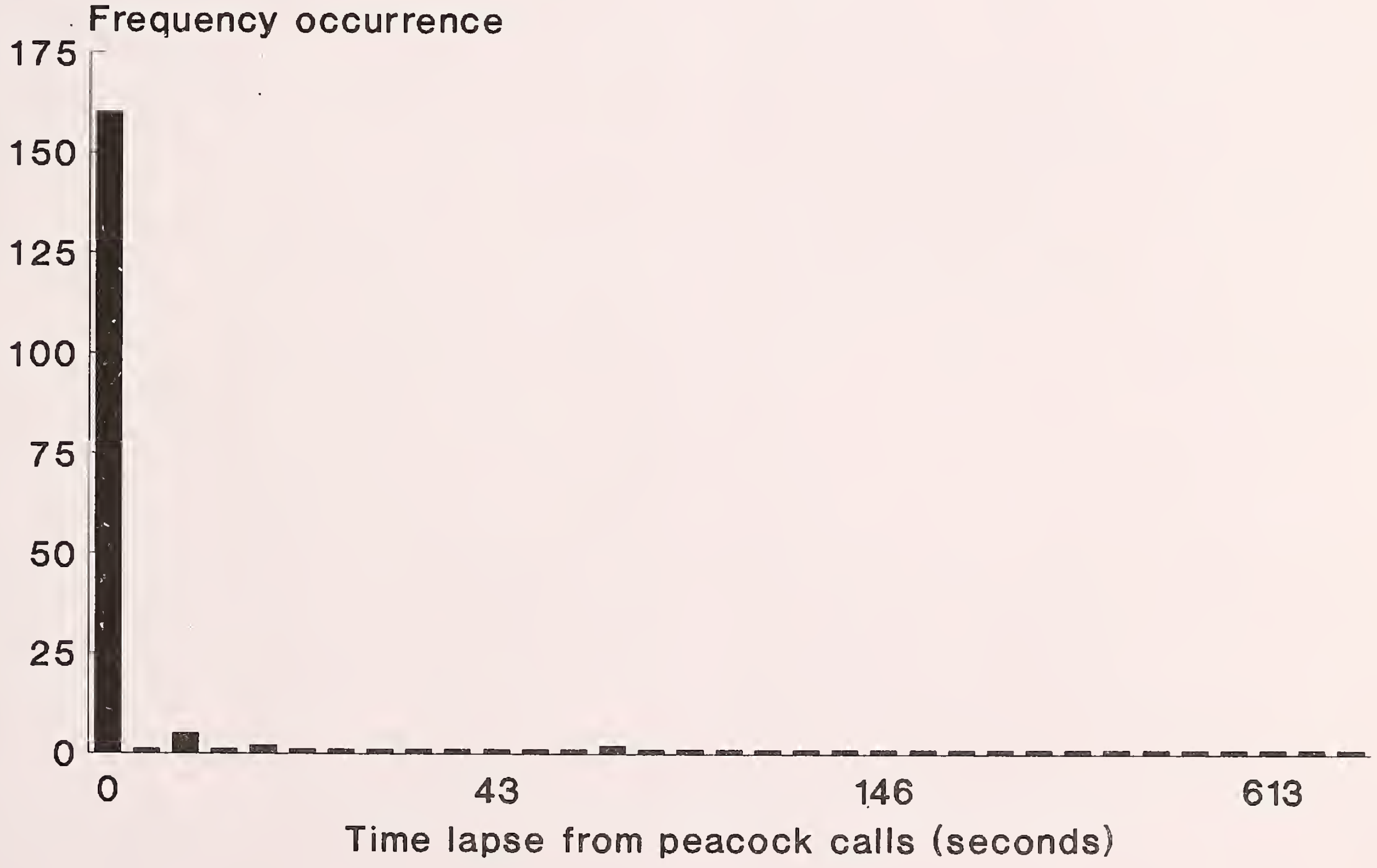


Fig. 4. The time lapse between peacock calls and the displays of male Bengal florican. Display at 0 seconds indicates that both display and calls occurred at the same instant. The effect of a trigger releasing display is instantaneous, and apparently does not have a delayed (or lag) effect.

by crow calls or which occurred independent of triggers (Table 3). However, though the mean duration of neck fluff was greater when flight display occurred independently of triggers than when triggered by crow calls, the data did not vary significantly.

Similarly, when not followed by display flight, neck fluff displays triggered by peacock calls had significantly shorter duration than neck fluffing without triggers. The duration of neck fluffing triggered by crow calls did not vary statistically from the other two, though the mean value was the highest (Table 3).

To see whether there was any variation in trigger effect in the loudness of peacock calls, I ranked calls as loud, medium or faint. Loud calls were those which were assessed to have been emitted within 150 m of the male florican, medium 150 - 300 m, and faint calls were over 300 m away. Of all peacock calls that acted as triggers, 49.48% were loud, 32.47% were medium, and 18.04% were faint.

Peacock calls are varied, but the three most common are the '*Mayaw-Mayaw*', the '*Kia-Kia*' and the '*Kok-Kok*' and variations of these calls. Of these the last is almost purely an alarm call while the former two are contact and/or territorial calls. Displays of the Bengal florican are mainly triggered by the '*Mayaw-Mayaw*' calls. Only on three occasions did the '*Kia-Kia*' call trigger displays, two of which were flight displays, and one was neck fluffing. Twice, variations of these calls triggered off flight displays.

DISCUSSIONS

There are two main features of the territorial displays of the Bengal florican that need emphasis. (1) The low number of displays that males perform during a display period and the lack of a distinct peak in display during the breeding season and (2) the existence of triggers and stimuli in territorial displays.

Territorial displays are signals that pass on information both to rival males and to females. Displays however are of many forms, and include at one extreme specifically evolved advertisements and at the other by simply being conspicuous within its territory by for example standing in a prominent position so that other individuals can easily see it. The form the display takes will determine the distance over which the message is signalled. Amongst bustards, both ground and aerial displays are seen, larger bustards have ground displays whose effective signalling distance is enhanced by males displaying from higher ground (e.g. Rahmani 1989). Small bustards have jumping displays because the effectivity of the signal is enhanced by the male rising above the vegetation.

However, a territorial signal will be effective only if it is performed frequently enough. Male lesser floricans display jump as many as 500 times a day (Sankaran 1991) and male great Indian bustards may perform their balloon displays for as long as an hour or more continuously (Rahmani 1989). For both these species, display is the prominent activity during the breeding season. In contrast, male Bengal florican perform less than 4 or 5 flight displays during a display period.

The frequency of aerial displays will be limited by, among others, body size. Adult male Bengal florican are medium sized bustard that weigh about 1.5 kg. I suggest that due to energy limitations brought about by size, frequent displays (like, for example, the lesser florican) cannot be performed. However, for territorial displays to be optimally effective, the message must be signalled frequently, or over a longer duration of time (as is the case with the lesser florican and great Indian bustard). The Bengal florican has two forms of displays. Aerial displays, in its grassland habitat have the function of signalling over longer distances. The ground displays, on the other hand have signalling value over shorter distances. I suggest that the low frequency of flight displays that signal over longer distances are compensated by advertisements that are effective over shorter distances.

The lack of distinct peaks in the display rate over the breeding season can be best explained by the nesting patterns in hens. Nesting occurs through every month of the breeding season (Baker 1921). This is an expected response as nesting habitat and food are abundantly available for most of the breeding season (Sankaran 1991). If receptivity in females is not concentrated to specific parts of the breeding season, and females solicit males throughout, then males too should not have distinct peaks in display rates.

Males occasionally display immediately on hearing a rival display, but more often males display a short while after a rival displays. I believe that this pattern is an expected one. A display signals a message, and in territorial displays it probably signals strength or ability to retain its territory. So a male should listen to or watch a rival male's display in order to assess the other before it responds. The few occasions when the males responded immediately to a rival's display by displaying can they be easily attributed to higher levels of pugnacity at that moment.

The calls of unrelated species acting as releasers of Bengal florican's displays is less easily explained. To explain why Bengal floricans display to calls of other species, I use a proximate approach rather than an ultimate one. The essential problem of using an ultimate approach is that possible explanations that were examined, did not account for the immediate response by the males to calls of unrelated species. I believe that the observed behavioural pattern can be explained by classical ethology from which period experimental demonstrations of complex behavioural patterns being triggered by a variety of objects exist (Gould 1982). Though this approach has lost popularity in recent times (McFarland 1985), the concept of the 'Fixed Action Pattern' and 'Sign Stimuli' has stood up to examination and shows no real sign of 'diminished usefulness' (Thorpe 1979). I believe that this approach is all the more valid in this case because, as a rule, territorial or courtship displays are innate and are not learned.

The sounds which trigger Bengal florican's territorial displays are diverse and include calls of peafowl, jungle crow, Indian pied hornbill, red wattled lapwing, swamp partridge and gunshots. Displays can be triggered by humans mimicking peacocks (Narayan and Rosalind 1988). It was thus apparent that it was not a call *per se* but sound which triggered displays. I suggest that this is a case of sound acting as a sign stimuli to release displays, in much the same pattern as has been demonstrated by Tinbergen (1951, 1972) for such diverse life forms such as butterflies, fish and birds.

I am unsure as to how this fixation of sounds triggering displays came to exist in the Bengal florican. One possible explanation lies in the observation of males being stimulated (sometimes immediately) to display on hearing the acoustic signal (wing clap) of the flight display of a rival male, and this perhaps leading to sound being fixed as a trigger in floricans.

The propensity of peacock calls triggering displays needs further perusal. If sound triggers display, then the loudest sounds are those that should elicit the most reactions ('super normal sign stimuli'; Tinbergen 1951, 1972). Peacock calls are amongst the loudest sounds in the Bengal florican's habitat and are therefore essentially 'super normal sign stimuli'. In the absence of loud calls, other sounds should release display as indeed indicated by the trends in data collected. This is also corroborated in the duration of neck fluff being significantly lower when triggered by peacock calls, thus indicating a stronger trigger effect, as is to be expected of the functioning of a 'super normal sign stimuli' (Tinbergen 1951, 1972). Though the existence of sign stimuli releasing fixed action patterns has several advantages, occasionally responses to cues which are obviously inappropriate exist, which with a slight increase of 'specificity in filtering mechanisms', might have been avoided (Gould 1982). This is important in context to the Bengal florican, because the sounds that trigger a complex breeding activity, territorial display, are cues that are irrelevant to its breeding.

Another question of interest is why has such behaviour evolved in this species, while in others, which also have acoustic components to display, such trigger patterns are not apparent?

A striking feature of Bengal florican attraction displays is their sporadicity. In 90% of observed display periods, males performed 7 or less flight displays; as each display flight has a duration of about 6.1 seconds, the time over which the male was actually displaying is minuscule. Thus display is not an activity that occupies time, but exists as individual acts. This is in striking contrast to other species of bustard, e.g. lesser florican where males can display at rates up to 2 or 3 jumps per minute for an hour or more (Ridley *et al.* 1985, Sankaran 1991), or the great Indian bustard, in which display also occupies considerable periods of time (Rahmani 1989).

I suggest that the existence of triggers in displays in the Bengal florican has arisen because of the sporadicity of its displays. In species where display occurs continuously over periods of time, a stimulus can elicit a bout of display but not each display act, as these are performed too frequently. In the Bengal florican, however, sporadicity of display has resulted in each display act being a single independent unit, i.e. one display flight is not immediately followed by another (as in the lesser florican) but after a significant time lag. Thus the fixation of unrelated triggers or the use of 'simple sign stimuli' to release behaviour sequences appears to be a function of the sporadicity or the rarity of the performance of an act.

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ECOLOGY AND MANAGEMENT OF CHITAL AND BLACKBUCK IN GUINDY NATIONAL PARK, MADRAS[1]

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(*With three text-figures*)

Key Words: Guindy National Park, *Axis axis*, *Antilope cervicapra*, population ecology, habitat use, feeding, wildlife management

We studied population size, density, and structure, seasonal habitat use, and feeding habits of chital and blackbuck in the 2.7 km² Guindy National Park, in Madras, Tamil Nadu, using line-transect sampling during 1991-92, and compared these with observations made during 1975-82 in the park. The chital population (density of 212.3/km² during 1991-92) has been stable or even increased between 1975 and 1992. Artificial feeding may be responsible for low fawn and adult mortality and thus for maintaining very high chital density. On the other hand, the blackbuck population has declined sharply from about 250 animals in 1979 to about 85 (density of 17.5/km²) today. Demographic changes include a lower fertility and a lower recruitment into the young male age classes. The likely causes for the decline are habitat changes in blackbuck territorial areas and competition with chital. There was much overlap in space use and food items of the two ungulates. Management measures such as habitat manipulation, cessation of artificial feeding, control of exotics, and introduction of blackbuck from other areas may be needed for saving the blackbuck in this insular park, once considered a stronghold of this endangered species.

INTRODUCTION

Guindy National Park (GNP), in Madras city (Tamil Nadu, southern India), harbours a diversity of animal and plant life (Selvakumar 1979, Selvakumar *et al.* 1981, Menon 1986a, Santharam 1986). It is an important remnant of the tropical dry evergreen forest of the Coromandel coast (Champion and Seth 1968). A substantial population of introduced chital (*Axis axis* Erxleben) and a smaller native population of blackbuck (*Antilope cervicapra* L.) inhabit GNP (Krishnan 1972). In the past, GNP has been regarded as one of the southern strongholds of blackbuck (Ranjitsinh 1989, Rahmani 1991), an antelope now given endangered status and placed in Schedule I of the Wildlife (Protection) Act of 1972 (Anon. 1992).

We (RS and RKGM) along with R. Selvakumar have been making ecological observations in GNP since 1974. By the early 1990s we had noticed a drastic decline in the blackbuck population. We then began a more systematic monitoring of the ecology of GNP particularly to understand the dynamics of chital and blackbuck and explore the causes of the latter's decline. In this paper, we present results (for 1991 and 1992) on population densities, demography, and seasonal habitat utilisation of chital and blackbuck, including a qualitative account of their feeding habits. These results, we believe, will be of value in formulating scientific management strategies.

STUDY AREA

Location and Area: GNP is a 2.7 km² park located in the southwest corner of Madras city (13° N, 80° E). Arterial roads to the city, and densely populated areas fringe GNP on the northern and western sides. A wall of 9.5 km perimeter surrounds the park, which also has an extensive network of roads (14 km) and trails. GNP has two large tanks (Kathan Kollai or KK Tank and Appalam Kolam or AK Tank) and two ponds, which have little or no water during the dry months (Fig. 1).

History: Before 1821, Raj Bhavan (then called the Guindy Lodge) was in private hands. In

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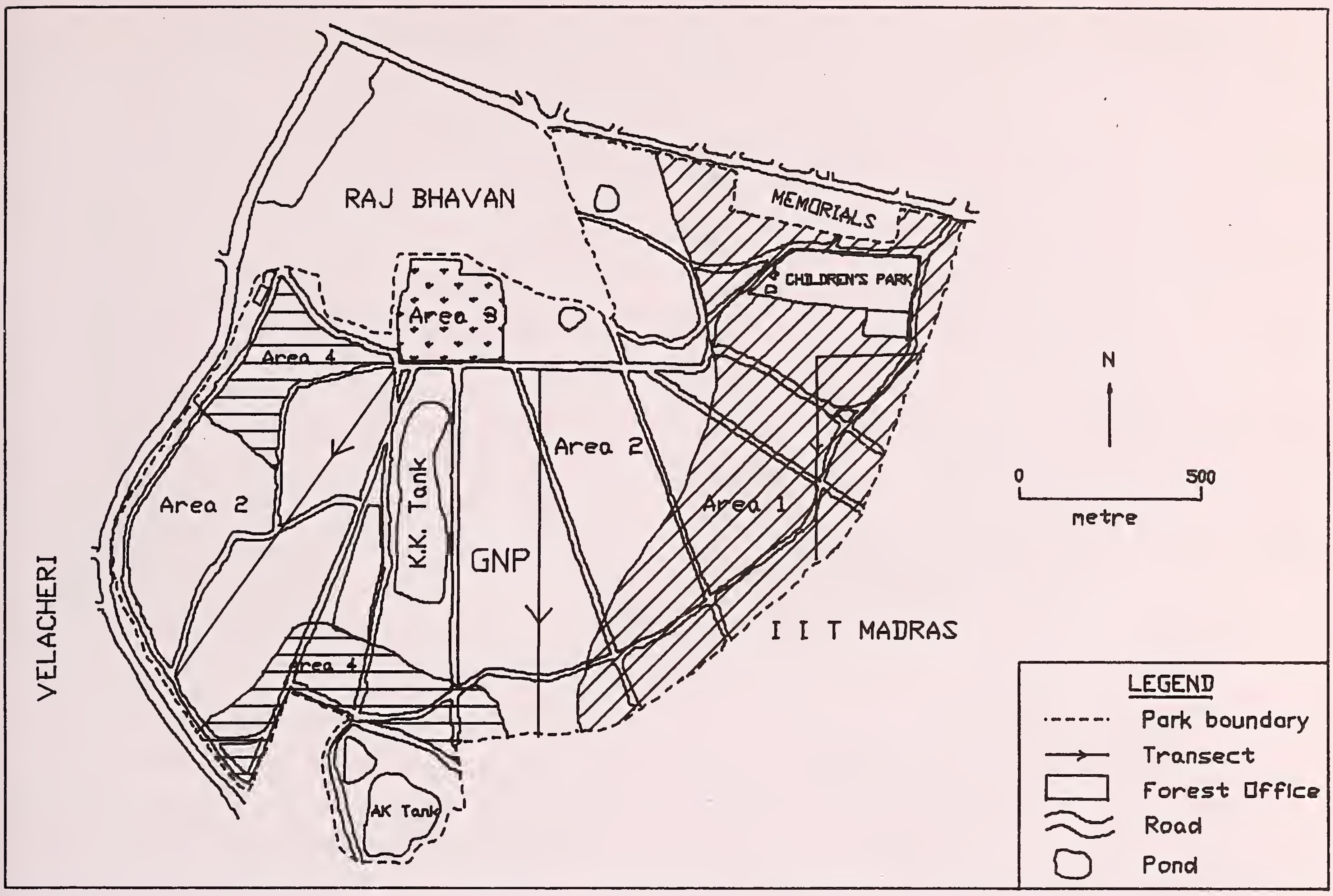


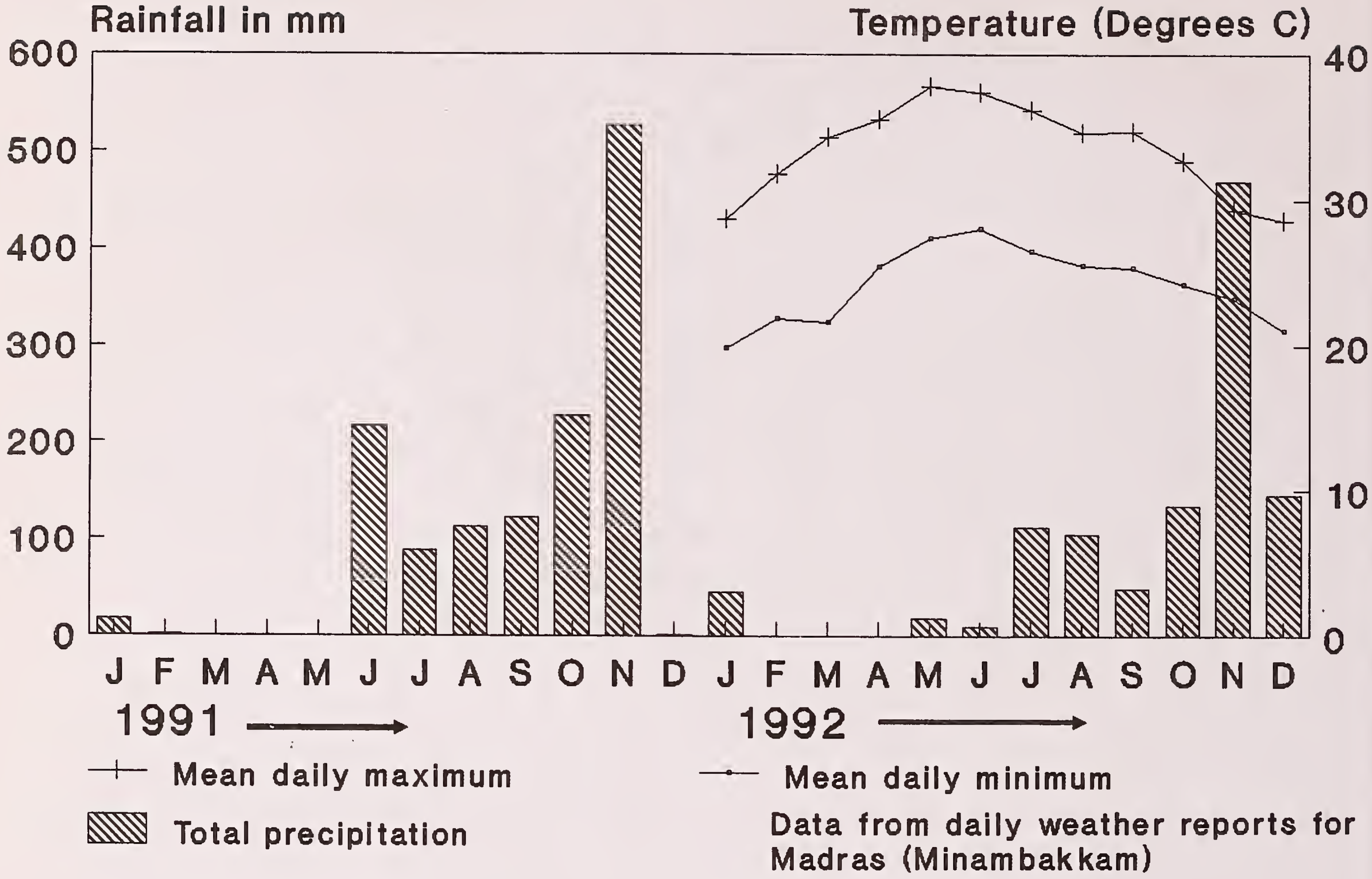
Fig. 1. Map of GNP showing habitat types, transects and surrounding areas.

1821, it was bought by the government and made the official country residence of the state Governors. The original area of about 505 ha. was declared a Reserved Forest in 1910. However, between 1961 and 1977, 172 ha. were set aside for various educational institutions and memorials. The remaining area popular as the Guindy Deer Park was, under suggestions from local naturalists, declared a National Park in 1978. More details about the history of the park are given by Menon (1986a).

While blackbuck are a native faunal element of GNP, chital were introduced into the park from the Government House on Mount Road when Raj Bhavan was developed (Krishnan 1972). The exact year of introduction is not given. However, Raj Bhavan became the only official residence of the Governor of Madras in 1946 (Chaudhuri 1990). Thus, the present chital population is probably derived from individuals introduced in the late 1940s. Some albino male blackbuck were also introduced by the Maharaja of Bhavnagar.

Climate: This region has a tropical dissymmetric climate (Meher-Homji 1974). The mean annual maximum and minimum temperatures are 32.9°C and 24.3°C. The mean annual rainfall is 1,215 mm (range 522 to 2,135 mm) (Climatological Table, India Meteorological Dept., Madras - Minambakkam 1931-60). The total rainfall in 1991 was 1,313 mm, while in 1992 it was 1,091 mm (Fig. 2). Based on rainfall pattern and water availability in the environment, we defined three broad seasons for this study.

(a) *Dry Season (January - March):* January, February, and March are the months of least mean rainfall - 25.8 mm, 6.3 mm, and 15.1 mm, respectively. Dew is an important source of moisture



Data from daily weather reports for Madras (Minambakkam)

Fig. 2. Monthly weather data for the study area, 1991-92.

during this season.

(b) *Summer or Pre-Monsoon Season (April - May):* This season is characterised by high temperatures, and erratic rainfall. This regime is believed to determine the peculiar vegetation of the Coromandel-Circar coast (Meher-Homji 1974, Puri *et al.* 1989).

(c) *Monsoon or Wet Season (June - December):* During this season, Madras receives rain from the south-west (SW) monsoon (June-September) and the north-east (NE) monsoon (October-December). Maximum precipitation occurs during October-November from NE monsoon depressions in the Bay of Bengal. In June 1991, there was 217 mm of rain, but poor rainfall in June 1992 necessitated inclusion of that month's data in the pre-monsoon season as hot, dry conditions prevailed.

Vegetation: GNP is an isolated remnant of the tropical dry evergreen forest (Champion and Seth 1968) once spread over the Coromandel-Circar coastal plains. This vegetation has been reclassified as the '*Albizia amara* Boiv. community' (Puri *et al.* 1989). Over 350 species of plants, both native and exotic have been recorded (Dr. C. Livingstone, pers. comm.). Physiognomically, it occurs as discontinuous or dense scrub-woodlands and thickets (see Meher-Homji 1973, 1974, Puri *et al.* 1989, for floristic aspects). Plant nomenclature in this paper follows Mayurnathan (1929) as updated by Matthew (1983).

The park can be divided into four broad habitats based on canopy and dominant plant species (see Fig. 1, Selvakumar 1979):

AREA 1: This area has nearly closed canopy dominated by introduced *Acacia planifrons*. There is a dense undergrowth dominated by *Clausena dentata* shrubs.

AREA 2: This area has semi-open scrub and thickets. The dominant tree is the palmyrah palm (*Borassus flabellifer*). *Randia dumetorum*, *R. malabarica*, and *Carissa spinarum* are very common.

Area 3: This is an open, cleared meadow called Polo Field which measures about 230 x 160 m. A total of 67 species of herbs, grasses, and sedges were collected from this area.

Area 4: This is probably a true remnant of the original vegetation of the region. Physiognomically similar to Area 1, it is characterized by presence of *Acacia chundra*, the exotic cactus *Cereus peruviana*, and predominance of *Glycosmis mauritiana* in the understory.

Fauna: Besides chital and blackbuck, other mammals such as bonnet macaque (*Macaca radiata*), jackal (*Canis aureus*), common mongoose (*Herpestes edwardsi*), small Indian civet (*Viverricula indica*), common palm civet (*Paradoxurus hermaphroditus*), blacknaped hare (*Lepus nigricollis*), threestriped palm squirrel (*Funambulus palmarum*), several species of bats and rodents are present. Nearly 150 species of birds have been seen in the park (Selvakumar *et al.* 1981, V. Santharam, unpubl.). Reptiles such as the saw-scaled viper (*Echis carinatus*) and the fan-throated lizard (*Sitana ponticeriana*) are typical. Nine species of amphibians and several fishes are known (R. J. R. Daniels, unpubl.) from the area.

METHODS

Density estimation: We collected systematic data on a monthly basis from January 1991 to December 1992. Three broad habitat types were identified for sampling:

(a) woodland (Area 1 & 4) occupying about 34% of GNP
(b) scrubland (Area 2) occupying about 59%, and
(c) grassland or Polo Field (Area 3) covering < 3% of the area.

Water bodies covered about 3% of the park area.

The line transect method was used to estimate animal density (Burnham *et al.* 1980). Three transects, each about 1 km long, were laid randomly and marked with paint. Two were placed in the scrubland, and one in the woodland to sample the habitats in rough proportion to their availability. Each transect was walked twice every month by one of us (TRSR). Sampling was uniform between the two time blocks of the day when animals were active (0600 - 0900 h and 1600 - 1900 h). A transect length of 6 km per month, or 144 km over the two years, was covered. For each sighting, the species, group size, age-sex data, and perpendicular distance from the transect line to the centre of the group (using a rangefinder) were noted. Total counts were made in the grassland every month. Data on age, sex, and group size were also collected along roads and trails. The mean group size (Y), and its standard error (SeY), were estimated by habitat type and season for the entire study area. All observations were made on foot.

The computer program TRANSECT (White 1987) was used to estimate density of groups (Dg, number of groups/km^2), and its standard error (SeDg), using the Fourier Series estimator (Burnham *et al.* 1980, Karanth and Sunquist 1992). The mean ecological density (D, number of individuals/km^2), and its standard error (SeD), were derived using standard equations (Drummer 1987 as used by Karanth and Sunquist 1992):

$$D = Dg \times Y$$

$$SeD^2 = SeDg^2 \times SeY^2/n + SeDg^2 \times Y^2 + SeY^2/n \times Dg^2$$

where: n - number of groups.

Population size was calculated by extrapolating density estimates to the park area excluding the area under water bodies (= 2.6 km^2). Blackbuck density was extrapolated to the park area excluding the grassland. The mean number in the grassland (derived from the systematic total counts) was added to the above estimate to derive the population size of blackbuck. A total count was carried out in GNP and Raj Bhavan to cross-check the results of the TRANSECT analysis. This was done mid-way through the study on 29 December 1991, when blackbuck were confined to the high-visibility open scrubland and grassland areas.

Demography: Chital were assigned to age-sex classes after Schaller (1967) and based on observations on known-aged animals in the adjacent Children's Park Zoo. Chital fawns were classified as small (< 2 months old) and big fawns (2-10 months old). Fertility rate of females was estimated by the method in Sinclair (1977). After the birth-peak and hiding period in January-February, changes in the proportion of fawns (per 100 females) could be followed easily between March and October. A regression equation of log proportion of fawns against time was calculated over this period. Assuming that all births occurred on January 1, projecting the above equation backwards gave the log proportion of pregnant females on January 1. Fertility would be underestimated in this method if mortality is higher in the first two months. However, converting to logarithms reverses this trend and the residual bias is low (Sinclair 1977: 171-3). The mean monthly mortality rate of chital fawns born in the early part of the year was also calculated over March-October in the following way: the instantaneous monthly mortality rate (z) was calculated as: $z = \log_e N_t - \log_e N_{t-1}$; where N_t = number of fawns/100 females in month t, and e is the base of natural logarithms (after Caughley 1977). This was translated into the finite monthly mortality rate as $1 - e^{-z}$. The mean monthly mortality rate was averaged over the months March to October and expressed as a percentage. Adult mortality was based on carcasses found; this being only a minimum measure of mortality.

Blackbuck were classified by horn, coat-colour, and body-size characteristics (after Schaller 1967, Mungall 1978, Selvakumar 1979) as adult males (age > 3 years), subadult males (age < 3 years), adolescent males (age < about 14 months), females, and fawns. Fawns were classified as small (age < about 1.5 months old) and big fawns.

RESULTS

CHITAL

Crude density of chital: The crude density of chital in GNP during 1991 and 1992 was 185.4/km² (± 29.3/ km² - 95% confidence interval) and 239.2/km² (± 37.2/km²), respectively. The mean population total shows a statistically significant increase from 482 in 1991 to 622 in 1992 ($z = 2.22$, $p < 0.05$; Table 1). However, it is emphasized that this trend needs to be monitored further before definite conclusions, can be drawn.

TABLE 1

CHITAL POPULATION DENSITY AND SIZE IN GUINDY NATIONAL PARK

Year	n	Density D/km²	Standard error of density SeD	CiD /km²	Total Population Mean P	CiP
1991	288	185.4	15.0	156.1-214.7	482	406-558
1992	379	239.2	19.0	202.0-276.4	622	525-719

CiD - 95% confidence interval of density.
CiP - 95% confidence interval of population.
n - Number of groups (sample size).

Seasonal habitat utilization of chital: The seasonal density of chital in a habitat type was often higher than the high crude densities reported above (see Table 2). The mean chital density in GNP over the two years was 212.3/km². A seasonal density in the considered habitat type greater or lesser than this, can be taken to indicate greater or lesser utilization, respectively. Data analysis showed a similar pattern of seasonal habitat utilization in both years. Hence, the two years' data were pooled (Fig. 3).

Dry Season: The woodland is now highly preferred by chital (Table 2). In January, many chital still used the scrubland and grassland. But as the season progressed, the use of these habitats decreased. Overall, the scrubland was underutilized and very few chital used the grassland (mean number on Polo Field = 4.3, range = 0-14, n = 37 total counts).

Summer or Pre-Monsoon: Chital continued to occur at a higher density in woodland than in scrubland or grassland. The grassland still had very few chital (mean number on Polo Field = 1.94, range = 0-8, n = 34 total counts). Seen relative to the available area, the woodland was overutilised, and the scrubland and grassland underutilised as in the Dry Season (Fig. 3).

Monsoon or Wet Season: The situation was reversed after the rains with chital density increasing in the scrubland and grassland, and decreasing in the woodland. Considerable numbers of chital aggregated in the grassland (mean number on Polo Field = 25.3, range 1-83, n = 85 total counts). The scrubland and grassland were clearly overutilised relative to the available area (Fig. 3).

General feeding habits of chital: During the dry season, chital frequently ate fallen fruits (e.g. *Ficus benghalensis, Albizia lebbeck, Limonia acidissima*) in the woodland. Much browsing occurred, mainly on *Randia dumetorum, R. malabarica,* and *Carissa spinarum.* Leaves of *Maytenus emarginata, Cassia roxburghii,* and *Syzygium cumini,* fruits of *Phoenix loureirii,* and the inflorescence of *P. farinifera* were eaten. From March

Table 2
SEASONAL HABITAT UTILISATION OF CHITAL IN GUINDY NATIONAL PARK, 1991-92

Season	Habitat	n	Density D/km^2	Standard error of density SeD	CiD /km^2
Dry	Woodland[a]	59	317.1	47.0	225.1-409.2
	Scrubland[a]	111	109.2	12.8	84.0-134.3
	Grassland[b]	37	107.4	16.5	75.1-139.7
Summer	Woodland	45	353.3	57.6	240.5-466.1
	Scrubland	86	119.9	14.4	91.7-148.2
	Grassland	34	48.5	12.8	23.4-73.6
Wet	Woodland	40	97.0	19.5	58.7-135.3
	Scrubland	318	279.0	18.7	242.5-315.6
	Grassland	85	632.3	62.3	510.2-754.4

CiD - 95% confidence interval of density.

a - Densities based on transect estimates; n - number of groups (sample size).

b - Mean density and its standard error (SeD) were calculated from systematic total counts for the grassland. The 95% CiD was calculated as mean ± 1.96 SeD; n - number of total counts.

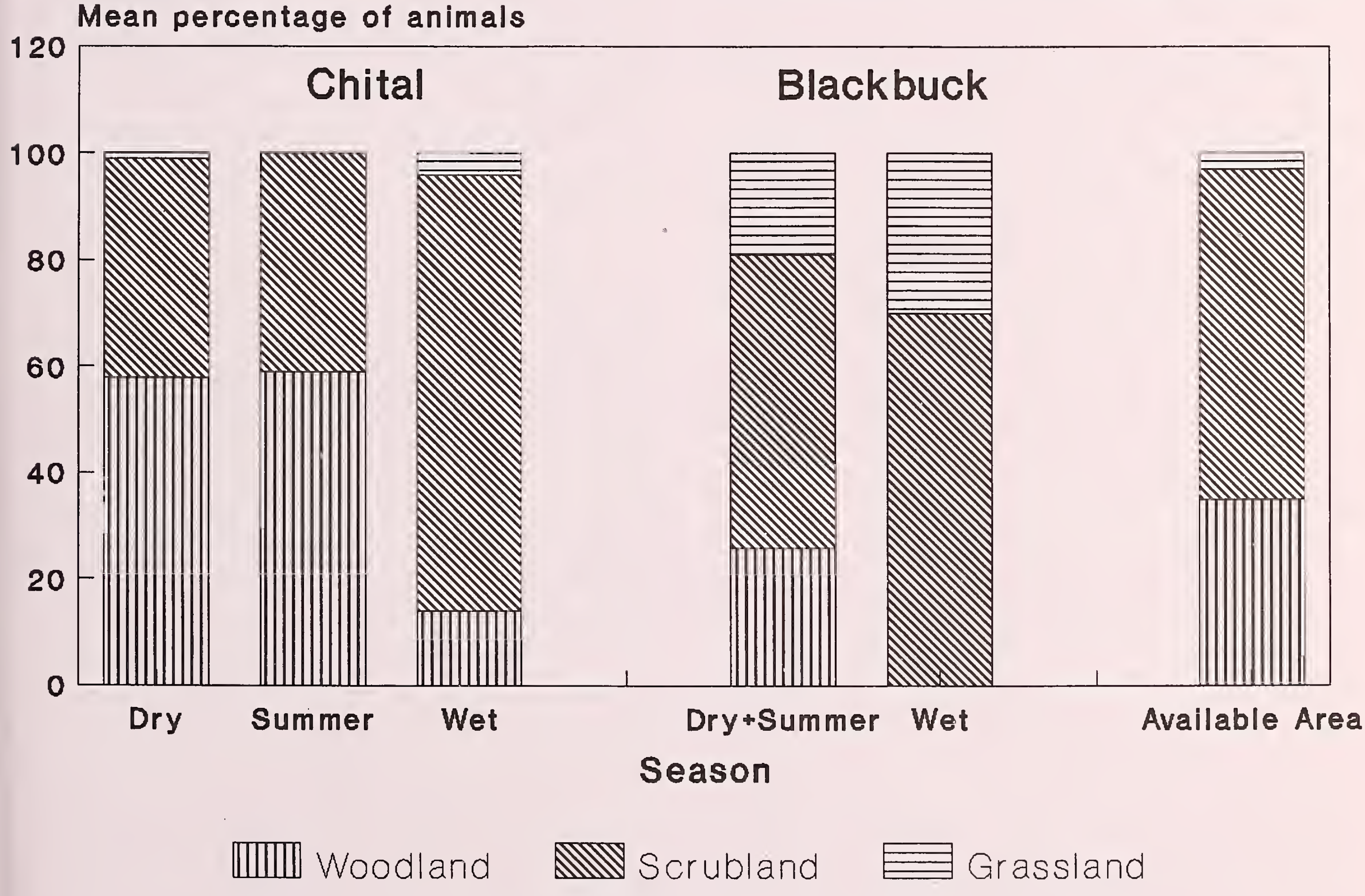


Fig. 3. Seasonal proportions of ungulates in the three habitat types, 1991-92.

onwards, chital also consumed the paragrass (*Brachiaria mutica*) provided by the Forest Department at ten feeding sites.

During summer, chital often fed on the pods of *Tamarindus indica* dropped by foraging bonnet macaques. Fallen fruits of *Acacia planifrons*, *Albizia lebbeck*, *Ficus benghalensis*, *Borassus flabellifer*, and *Phoenix sylvestris* were also eaten. One rumen examined, had seeds of *Polyalthia longifolia*. Browsing occurred on both *Randia* species, *Capparis sepiaria*, and *Canthium parviflorum*. Chital commonly grazed near the edges of ponds and fed on garbage along the park periphery. Aggregations of 20-50 chital fed at the artificial feeding sites in the evenings.

During the early wet season, chital were most frequently seen grazing. They ate many common grass species: *Heteropogon contortus*, *Cynodon dactylon*, *Cymbopogon flexuosus*, *Eragrostis* sp., *Vetiveria zizanioides*, and *Aristida setacea*. Many grasses appeared extensively grazed and stunted, compared to other scrub-jungles near Madras. Sedges (*Fimbristylis* sp.), and herbs like *Limnophila indica*, and *Spermococe articularis* were also eaten. Chital fed on fallen fruit, as of *Syzygium cumini*, *Madhuca indica*, *Lannea coromandelica*, and *Prosopis juliflora*. During the late wet season, browsing is again frequent, especially on *Randia malabarica*, *R. dumetorum*, *Carissa spinarum*, and *Ziziphus xylopyrus*.

Chital consumed many garbage items along the park periphery, including paper, polythene, cardboard, popcorn, surgical cotton, and even human faeces (on two occasions). They were also seen chewing on bones and bark, on one occasion each.

Demography: During this study 11,828 chital were classified (sampling with replacement, Table 3). The sex ratio was biased towards females (100:47.2 in 1991 and 100:47.6 in 1992). The female:fawn ratio was 100:18.0 and 100:14.1 in the two years, respectively. There was a birth-peak in January-February (T.R.S.Raman, unpubl. results). An estimated 47% of the adult females were pregnant on 1 January 1991, but the figure for 1992 was only 15%.

TABLE 3

POPULATION STRUCTURE OF CHITAL IN GUINDY NATIONAL PARK

Age/sex Class	1991 %	1992 %
Females	49.2	53.4
Yearling Females	9.9	7.0
Fawns	8.8	7.5
Yearling Males	8.8	6.6
Juvenile Males	23.2	7.2
Adult Males		18.2
Number of animals classified, N	4981	6847

The mean monthly mortality rate of fawns was 9.7% between March and October 1991, but in 1992 mortality was negligible (0%). Data on adult deaths in 1991 were not collected. In 1993, eight adult chital carcasses were found during the dry season, from late February to early May, only one of which was probably a feral dog kill. This was higher than the number of deaths (2) recorded over a comparable period in 1992.

BLACKBUCK

Crude density of blackbuck: The crude density of blackbuck in 1991 and 1992 was 19.6/km^2 (± 6.4/km^2; 95% confidence interval) and 15.3/km^2 (± 4.4/km^2), respectively. The decrease in mean density between 1991 and 1992 is not statistically significant ($z = 1.09$, $p > 0.05$). The average density for 1991-92 (17.5/km^2) extrapolated to the park area excluding Polo Field gives a population of 45 (± 15) animals. This, added to the mean number of blackbuck on Polo Field (15.0, n = 151 total counts), gives a population of 60 (± 15) blackbuck (Table 4). In the total count, 40 animals were enumerated. Since some may have been missed and a small area could not be censused, we estimate 40-50 blackbuck in GNP. In Raj Bhavan (RB), 25 blackbuck were enumerated in the total count. The population in GNP and RB taken together is thus 85 (± 15) animals. This is much lower than past estimates and the

TABLE 4

BLACKBUCK POPULATION DENSITY AND SIZE IN GUINDY NATIONAL PARK

Year	n	Density D/ km^2	Standard error of density SeD	CiD D/km^2	Mean Population (excl. Polo Field)	Mean no. in Polo Field	Total Population	CiP
1991	50	19.6	3.3	13.2-26.0	51	16.5	68	51-85
1992	48	15.3	2.2	11.0-19.7	40	14.0	54	43-65

CiD - 95% confidence interval of density.
CiP - 95% confidence interval of total population.
n - Number of groups (sample size).

possible reasons for this decline form the major focus of this paper (see Discussion).

Seasonal habitat utilisation of blackbuck: The data for the dry season and summer were pooled to obtain sufficient sample size for TRANSECT analysis. Blackbuck used the woodland only during the dry months (Fig. 3). Density estimates for the scrubland and the grassland are given in Table 5.

Dry season and Summer: The mean density of blackbuck in the scrubland during this period was 18.2/km^2. To obtain a relative estimate of blackbuck use of the woodland we compared the number of blackbuck groups seen within 10 m from the transect line (visibility bias thus being small) in the scrubland and woodland. In 22 km of transect, 7 groups were seen in the woodland, and 8 in the scrubland, indicating almost equal usage. On the grassland (Polo Field), an average of 14.6 and 6.5 blackbuck were seen during the dry season and summer, respectively (n = 35 and 33 total counts, respectively). Fewer blackbuck were seen on Polo Field in the mornings than in the evenings. While the scrubland and grassland were used more or less in proportion to availability, the grassland was highly preferred by blackbuck (Fig. 3).

Wet season: The blackbuck avoided use of the woodland and concentrated in the scrubland and grassland areas after the green flush of vegetation following the rains. The mean density in the scrubland increased slightly, and the Polo Field grassland became the primary centre of blackbuck activity. The mean number of blackbuck on Polo Field was 17.9 (n = 83 total counts) during this season. Both the scrubland and grassland were overutilized when seen relative to available area (Fig. 3).

TABLE 5

SEASONAL HABITAT UTILISATION OF BLACKBUCK IN GUINDY NATIONAL PARK, 1991-92.

Habitat	Season	n	Density D/km^2	Standard error of density SeD	CiD /km^2
Grassland	Dry	35	365.0	35.5	295.4-434.6
(Polo Field[a])	Summer	33	162.0	25.5	112.0-212.0
	Wet	83	448.3	20.8	407.6-488.9
Scrubland[b]	Dry+Sum	36	18.2	3.8	10.7-25.7
	Wet	49	25.9	3.7	18.6-33.1

CiD - 95% confidence interval of density.
a - Mean density and its standard error (SeD) were calculated from systematic total counts. The 95% CiD was calculated as mean ± 1.96 SeD; n - number of total counts.
b - Densities based on transect estimates; n - number of groups (sample size).

General feeding habits of blackbuck: During the dry season, blackbuck in the woodland foraged in small clearings, or along road edges. They browsed extensively on *Carissa spinarum, Randia dumetorum*, and *R. malabarica*. Fallen fruits of *Pithecellobium dulce* and leaves of *Aegle marmelos* were also eaten. Only twice, in the late dry season a male was seen feeding at the artificial feeding site on Polo Field, when no other animals were present.

Many blackbuck feed on dry, coarse grasses in Polo Field and near KK Tank, especially in the evenings.

In the wet season, blackbuck mostly grazed on grasses such as *Aristida setacea, Cynodon barberi, Heteropogon contortus, Cymbopogon flexuosus, Chrysopogon fulvus, Vetiveria zizanioides,* sedges such as *Fimbristylis ovata*, and herbs such as *Justicia prostrata* and *Indigofera linnaei*. These plants were common in Polo Field and nearby open areas.

Demography: During the study, 3,108 blackbuck were classified (sampling with replacement, Table 6). The adult sex ratio was 100:21.0 (females : males) in 1991, and 100:18.8 in 1992. The proportion of sub-adults and young declined from 13.2% in 1991 to only 6.3% in 1992.

Table 6

POPULATION STRUCTURE OF BLACKBUCK IN GUINDY NATIONAL PARK

Age/sex class	1991 %	1992 %	1979[a] %	1979[a] Number
Female (Ad+Yrl)	71.6	78.8	58.4	152
Adult Male	15.0	14.8	8.9	35
Sub-adult Male	4.2	3.8	23.5	49
Adolescent Male	4.4	0.0	5.0	13
Fawns	4.6	2.5	4.2	11
Number of animals classified	1484	1624		260

a - From Selvakumar (1979), (total count).

The female: fawn ratios were 100:6.4 and 100:3.1, respectively. In 1991, most births occurred in September-October, while in 1992, most births were in November-December (T.R.S.Raman, unpubl. results). Thus in 1991, the fawn: female ratio peaked at 27.8:100 in October, while in 1992, it was highest at just 10.5:100 in December. Fawn mortality was difficult to estimate. Out of five fawns regularly seen with the blackbuck herd on Polo Field in November-December 1992, only two were seen with the herd in January 1993.

Predation: In GNP, the only natural predators are a few (about 6-12) jackals and some feral dogs. Both jackals and dogs chased chital and blackbuck on several occasions. The albino blackbuck male suffered a large wound on its thigh after being attacked by two jackals in 1993, but managed to survive.

Discussion

POPULATION TRENDS IN CHITAL AND BLACKBUCK

The average population size of chital and blackbuck in GNP in 1991-92 was 550 and 60, respectively. Comparison with past data suggests that while chital have either remained stable or increased slightly in numbers, the blackbuck have declined drastically.

Selvakumar (1979) reports a population of 360 chital for 1979. This is probably an underestimate and should be taken as the minimum number, as the total count method used (in which RS and RKGM participated) would have missed animals in dense vegetation. Menon (1982) used line transects and estimated an average population of 520 chital in 1981-82. The current trend (1991-92, this study) appears to be one of increase.

In contrast, blackbuck were far more numerous in the past. An average of six censuses (Forest Dept. records, total counts and transects) in 1975-80 gives a total of 295 blackbuck. Selvakumar (1979) likewise estimated 260 blackbuck in 1979. The average of four line-transect estimates in 1981-82 was 333 blackbuck (Menon 1986a, unpubl. data). These estimates and other observations (by RS and RKGM) clearly showed that at least 250 blackbuck inhabited the combined GNP and Raj Bhavan areas till 1981. The current trend (1991-92, this study) appears to be one of decline, with a population of only 85 animals.

BLACKBUCK DECLINE: ROLE OF HABITAT CHANGES

Provided that obvious requirements such as food, space, and water are available, a major requirement for free-ranging blackbuck is the opportunity for the males to express territorial behaviour. Non-territorial males rarely reproduce (Walther *et al.* 1983). Blackbuck are well known to prefer open areas for their territorial activities and feeding. The availability of such habitats is thus likely to be a decisive factor in blackbuck population dynamics. For instance, in this study, Polo Field, the main territorial ground, occupying less than 3% of GNP's area held about 25% of the blackbuck population through the year (Fig. 3). Loss of this small area can disproportionately lower the population that can be retained in GNP.

While no quantitative data exist regarding habitat changes in GNP over the last 15 years, certain striking aspects are evident. Based on comparative notes kept on the vegetation of the Park in the 1970s by one of us (RS), we find that the major changes are:

i) *Vegetation change and deterioration of territorial areas:* Polo Field, in 1979 was an open meadow occupied by five to six territorial males (Selvakumar 1979, RKGM, unpubl. data). During the current study, it was found overrun by numerous weeds (*Cassia tora, Cassia occidentalis, Croton bonplandianus, Sida cordifolia,* and *Prosopis juliflora*) and tree saplings (*Cassia fistula, Borassus flabellifer*), until cleared by the Forest Department in April 1992. The number of territorial males on Polo Field during the current study was never more than 2 until the rut of April 1992. After the weeds on Polo Field were removed, 3 males were regularly seen there. A fence now separates this area from Raj Bhavan.

Two other open areas used by blackbuck in the past have been lost. The first is an area classified by Selvakumar (1979) under AREA 3. In 1984-85, this 2.5 ha. area west of KK Tank, was fenced off to grow grass for the animals in Children's Park zoo. The area is almost wholly unused now. While many chital easily get across the partially collapsed fence, only two blackbuck males were seen inside in 1992. Female blackbuck shy away from entering this area. When under our suggestions, a portion of the fence was removed, female blackbuck were seen using the area (A. T. F. Vanak, pers. comm.) and males were observed initiating territorial activity (RKGM, pers. obs.). The second grassland area that has been lost, along the eastern bank of the KK Tank, is now overrun by dense clumps of *Acacia auriculiformis* trees and saplings.

Other vegetation changes may not have been evident. *Dodonaea viscosa*, once a common plant in the Park, is now rare. The fate of many other species is not known.

ii) *Increase in plant biomass:* The vegetation in many areas is clearly much denser today. The undergrowth of *Clausena dentata* in AREA 1 is now almost 1 - 2 m taller (and denser) than it was in the 1970s. As mentioned earlier, Polo Field too has been overrun with shrubs and weeds. Some areas included by Selvakumar (1979) in AREA 3, are indistinguishable from AREA 2 now. These areas were also grazing grounds for cattle in the past. The exclusion of livestock may have contributed to the growth in the vegetation.

There is also a large influx of biomass into the Park every year in the form of artificial fodder. One ton fresh weight (or an estimated 350 kg dry weight) of grass, provided for about 100 days each year for the last 15 years, totals 525 tons dry weight of biomass (nearly 200 tons/km²). This large influx of biomass may have upset the nutrient cycles in GNP leading to an increase in woody and herbaceous vegetation. The curtailment of wood-poaching by the Forest department in recent times could also have led to an increase in woody vegetation. This may have shaded-out the growth of grass in some areas, forcing chital to forage in other places such as Polo Field.

iii) *Fragmentation:* GNP has lost considerable area in the past to memorials and educational institutions, and has been isolated from the adjacent Raj Bhavan and the Indian Institute of Technology (IIT) campuses by physical barriers. It is not known when the Raj Bhavan fence was built, but the wall separating IIT and GNP was built in the late 80's and completed by about 1989. It is unlikely that the observed blackbuck decline is a simple result of the sub-division of a once-contiguous population, with the blackbuck lost by GNP being gained by other areas. Our observations suggest that there has been a parallel decline in blackbuck numbers in IIT also (RKGM and TRSR, unpubl. data). In GNP, the fragmentation is likely to have mainly affected the spatial distribution of blackbuck territories (especially between GNP and Raj Bhavan) and seasonal movements of the ungulates.

BLACKBUCK DECLINE: COMPETITION WITH CHITAL

While habitat changes are likely to be the primary cause for the blackbuck decline, competition with the high-density chital population may be another important factor. Chital are a highly adaptable species (Krishnan 1972) and may be exerting considerable competitive pressure on blackbuck for food and space. The density of chital in GNP was higher than in other areas for which information is available (Table 7). Competition is possible as chital and blackbuck share many food items in common (see Feeding Habits). Also, during the wet season, chital are found in large numbers in the scrubland and grassland areas which are prime blackbuck habitats. Polo Field may be occupied by as many as 100 chital in October-November in the evenings, physically disrupting the blackbuck herd, and the territorial behaviour of males, as has been noticed on a few occasions.

Table 7

ECOLOGICAL DENSITIES OF CHITAL IN OTHER NATURAL AREAS

Place	Chital density D/km^2	Source
Bandipur, Karnataka	36-85	Sharatchandra & Gadgil 1975
	43-45 (up to 120)	Johnsingh 1983
Chitawan, Nepal	15.4-17.3	Seidensticker 1976
Corbett, U.P.	45.5-49.3	De & Spillett 1966
Gir, Gujarat	42.3-53.9	Khan *et al.* 1990
Kanha, M.P.	23.2	Schaller 1967
Karnali Bardia, Nepal	90.4-114.2	Dinerstein 1980
Nagarahole, Karnataka	50.6	Karanth & Sunquist 1992
Powderhorn, Texas	18.9	Ables 1974
Wilpattu, Sri Lanka	12.1	Eisenberg & Lockhart 1972

How are chital maintained at such high densities in GNP? A natural factor may be that the vegetational diversity and edge-to-forest ratio in GNP is high (Eisenberg and Seidensticker 1976). However, the other contributing factors are artificial feeding of chital and low mortality from predation.

i) *Artificial feeding:* In temperate Parks, artificial feeding during winter is known to maintain populations of deer at higher densities, with lower mortality, higher body weight, and better reproduction (Putman and Langbein 1993). In GNP, when no feed was provided, fawn mortality (in 1991) and adult mortality (in 1993) were high. In contrast, mortality was much lower in 1992, when artificial feed was provided. Artificial feed may also help chital attain higher fertility due to improved nutritional status during the dry months, which coincides with the peak rut of chital in GNP (Miura 1981, T. R. S. Raman, unpubl. results). The absence of artificial feeding in 1991 would then explain the lower fertility observed in 1992.

Blackbuck do not seem to prefer the artificial feed provided. Possibly, the milling aggregations of 20-50 chital at these feeding sites physically deter blackbuck. Aggressive interactions between chital and blackbuck have been recorded at feeding sites in Texas (Walther *et al.* 1983: 216). Thus only chital benefit from the artificial feed provided.

ii) *Low mortality from predation:* Many large mammal populations are limited by predation, and increase when predators are removed (see Sinclair 1989, for a review). Menon (1987) gleaning data from Forest Department records reported that, in 1979, a total of 107 deer (about 17% of the total population) were killed by feral dogs. While few kills may have been due to jackals, dogs are the most important predators of chital in GNP. Blackbuck mortality to dogs was not high in GNP and IIT compared to chital (Menon 1986b). No data are available regarding the total number of kills during the current study. However, in 1992, the Forest

Department sanctioned the shooting down of dogs in GNP, thus removing this source of mortality of chital.

TRENDS IN HABITAT UTILISATION

Understanding the seasonal distribution and movements of the ungulates in GNP is important in considerations of the dynamics of the two species. The seasonal movements of chital and blackbuck were clearly governed by the availability of food in the three habitat types. Between January and May, drying up of grass forage in the scrubland and grassland led to frequent browsing and increasing use of woodland. In summer, most trees set fruit (Rajasekhar 1992) and shed their leaves, and these are then consumed. After the first monsoon showers, the grass flush in the scrubland and grassland induce high utilisation of these areas. This is not surprising as both species are predominantly grazers (Mungall 1978, Mishra 1982). Late in the season, as the grasses mature, there is a return to frequent browsing presumably because deeper-rooted browse species produce fresh growth even after the rains cease.

While this pattern is similar to the one described by Selvakumar (1979), two notable differences exist. In the past, considerable movement, especially of chital, used to occur between GNP and the surrounding areas (Menon 1982). Today, with the walling-up of GNP it has become a small, closed system. Secondly, systematic total counts of chital and blackbuck on Polo Field during 1977-78 by one of us (RKGM) showed few chital (up to 12 or so individuals) and many more blackbuck on Polo Field (Table 8). Currently, the reverse situation, with more chital on Polo Field during the wet season, prevails. The maximum number of blackbuck seen on Polo Field during the current study was 29, and chital was 102. Poor availability of grass forage in other areas due to dense growth of woody vegetation may be responsible for the present shift to the grassland.

Table 8

SOME PAST TOTAL COUNTS OF BLACKBUCK ON THE POLO FIELD GRASSLAND

Date	Males	Females	Total
06.08.1977	3	14	17
06.11.1977	19	45	64
16.11.1977	10	43	53
11.12.1977	5	29	34
15.01.1978	5	31	36
10.031978	—	—	53
30.05.1978	19	31	50

VIABILITY OF THE BLACKBUCK POPULATION

Small, isolated populations of wild animals are vulnerable to extinction through demographic, environmental, and genetic stochasticity, and catastrophes such as disease epidemics (Shaffer 1981). In this light, several aspects of blackbuck demography require attention.

Currently, the proportion of fawns and young males in the population is much lower than in 1979 (Table 6). Fewer fawns are seen per female than in other blackbuck populations in places like Mudmal (Prasad 1983), Point Calimere (Natarajan 1989), areas reported by Schaller (1967), Velavadar and Tal Chapar (Ranjitsinh 1989). The percentage of fawns in the GNP population declined from 4.6% in 1991 to 2.5% in 1992. Also, in 1992, no adolescent males were seen at all in GNP, indicating total lack of recruitment into that age class. At present, there are just 8 adult blackbuck males in GNP and 2-3 younger males. In terms of behaviour, the presence of younger males may play a beneficial role in influencing territorial behaviour and reproduction of adult males (Walther *et al.* 1983). Currently, large mortality of adult males in any year may spell disaster for the blackbuck in GNP at prevailing recruitment rates.

The sex ratio of blackbuck in GNP is more biased towards females than in the other natural areas mentioned above and even when compared to the population in 1979. If only some of the eight adult males in the population are doing most of the breeding, it would decrease the effective population size and accentuate inbreeding (Frankel and Soulé 1981).

Selvakumar (1979) found that the August-October rut of blackbuck contributed the major proportion of the annual fawn crop the following January-April. During this study, the March-April rut contributed most of the fawn crop, with births occurring almost entirely during September-December. The reasons for this reversal are not evident. Increased interference by large chital aggregations on the territorial activities of blackbuck on Polo Field during the October rut may be a reason.

PRACTICAL CONSIDERATIONS AND MANAGEMENT

What are the conservation objectives that define feasible management options for GNP? We suggest that GNP can serve as a useful reserve for maintaining a viable population of blackbuck, preserving the remnants of the natural vegetation, and addressing social and educational functions of the park in Madras city. The following management suggestions are made in the light of this study:

1. *Habitat manipulation* can be used to improve and increase the territorial grounds of blackbuck in GNP. This can be targeted at two particular areas without disturbing the natural vegetation of the Park:

(a) the defunct 2.5 ha. grass plot west of KK tank - where the entire fence surrounding the plot must be removed to allow free access to blackbuck males and females, and (b) the area east of KK tank - where the profusely growing clumps of *Acacia auriculiformis* can be removed.

As these areas are close to Polo Field and represent past territorial grounds, they are likely to be used by blackbuck when these changes are made. Close monitoring will yield valuable information on the results of such management measures. Periodic control of weeds and woody plants on Polo Field will also be beneficial.

2. *Reduction in chital numbers* can be achieved by allowing natural mortality factors to operate. Artificial feeding of chital during the dry season and the shooting of dogs should stop. Stopping artificial feeding is also important to stop the inflow of large quantities of biomass into the Park.

Stopping artificial feeding may have slightly deleterious effects on the blackbuck in the short term, as chital may eat a greater amount of food during the dry season, which may otherwise be available for the blackbuck. However, in 1991 and 1993, when artificial feeding was either not carried out or minimal, the blackbuck population did not seem to be affected by increased competition with chital. This is probably because, during the dry season, many blackbuck feed on dry and coarse grasses in areas like Polo Field and near KK Tank, where few chital feed.

3. *Control of exotic plants*, specifically *Acacia auriculiformis, Prosopis juliflora, Antigonon leptopus*, and *Cereus peruviana* is suggested. The vegetation in AREA 4 can be targeted for intensive protection from invasion by exotics, wood-removal, and disturbance, as a 'remnant' patch of the tropical dry evergreen forest.

4. *Introduction of a few blackbuck* from other areas, including some sub-adult males from IIT, is recommended to counter inbreeding depression and loss of demographic vigour, and modify the distorted population structure. Standard guidelines suggested for such introductions can be followed (Sale 1986).

5. *Regular, long-term monitoring* of the ecology of the Park will be valuable in assisting management. Monitoring population trends, mortality, and results of management actions such as habitat manipulation, will be useful.

CONCLUSIONS

The decline of blackbuck in GNP illustrates that mere protection of a National Park may not be enough to ensure its viability. Prudent and interactive management is called for, especially in parks like GNP. GNP represents the plight of many such small, isolated nature reserves. Maintaining a viable population of blackbuck in GNP is however a feasible and challenging task. The experience so gained will be useful in management of other sanctuaries in the country. GNP harbours a remnant of tropical dry evergreen forest vegetation which today occupies only 1% of the potential area along the Coromandel coast (Meher-Homji 1986). In Chingleput District, near Madras, satellite data show that over 99.9% of the area under scrub-jungle vegetation has been lost (P. Dayanandan, pers. comm.). Conservation of GNP is also important for tapping its valuable potential as a field laboratory to train students in the field of ecology and to educate tourists about conservation.

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POLLINATION ECOLOGY OF *DURANTA REPENS* (VERBENACEAE)[1]

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(*With three text-figures*)

Key words: *Duranta repens*, butterflies, moth, *Macroglossum gyrans*, pollination

Duranta repens L. flowers chiefly during July-December. Anthesis is staggered round the clock and the flowers offer pollen and nectar as the reward to their insect visitors. The flowers are small and hermaphrodite. Nectar is secreted in measurable quantity on the first day, but only in traces on the second day. The nectar sugars are sucrose, glucose and fructose. Sucrose is predominant. Sugar concentration ranges from 12-21%. Protein and amino-acids too are present. The breeding system includes both geitonogamy and xenogamy.

A total of 30 diurnal insect species which are diurnal in their activity were found foraging at the flowers. The bees collected pollen as well as nectar from the flowers. Whereas the wasps, the butterflies and moths collected the nectar only. Heads of the bees and wasps, proboscids of the moths, proboscids and legs of the butterflies were seen touching the anther and stigmas thereby effecting pollination in the *D. repens*.

INTRODUCTION

Compared to bees the amount of research carried out in establishing butterflies' role in natural pollination is meagre. The dearth of information in the field of butterfly pollination was realised as early as 1949 by Verne Grant. Even then there are not many additions to the literature on butterfly pollination.

However, there are some studies highlighting the role of butterflies in the pollination of certain plants (Moldenke 1976, Cruden and Hermann-Parker 1979, Pajni and Sukhwinder Kaur 1979, Courtney *et al.* 1983, Bawa *et al.* 1983, Webb and Bawa 1983, Jennersten 1984, Subba Reddi & Meera Bai 1984, 1986; Meera Bai 1987, Byragi Reddy and Aruna 1990). These studies stressed the need to undertake detailed studies in different geographical regions to appreciate the role of butterflies in pollination.

The present paper deals with the interactions of *Duranta* and its pollinators in Visakhapatnam with special reference to butterflies.

MATERIAL AND METHODS

Duranta repens L. a hedge plant planted at Visakhapatnam (17° 42' N and 82° 18' E) was utilised for the study. Mature buds were identified based on the blue colour development on corolla. To record the anther dehiscence time: floral buds of different stages were slit open and observed with the help of a field macrolens of 10x magnification. Pollen output per anther was assessed by counting all the pollen grains in a sample obtained by gently crushing and tapping the anther on a clean microscope slide and spreading the pollen mass uniformly. Similarly, the pollen deposited on the stigmas were assessed at regular intervals. The inflorescences were bagged in the early hours (0500 hr) in order to have virgin flowers for controlled experiments. As and when the desired insect alone visited the virgin flower, the stigmas were immediately plucked and screened for the pollen loads. The longevity of pollen and stigma was assessed based on the fruit set success from hand-pollinations at regular intervals. The flowers to be hand-pollinated were emasculated in the bud condition. Test for apomixis/autogamy, geitonogamy, xenogamy were conducted through controlled pollinations. Apomixis was tested by bagging the emasculated flowers free of pollen, autogamy by pollinating flowers with the pollen of the same flower, for geitonogamy with the pollen of different flowers of conspecific plant, and for xenogamy with the pollen of the different conspecific plants.

Nectar produced in flowers protected from

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insects for a 3 hr period was measured using disposable micro-pipettes. Refractometer was used to determine nectar sugar concentration. Paper chromatography was used to determine nectar sugar composition (Harborne 1973). Amino acids and proteins were identified by the method of Baker and Baker (1973).

Insect foragers other than butterflies collected during the study period were identified through the courtesy of commonwealth Institute of Entomology, London and Zoological Survey of India, Calcutta. The butterflies caught over the flowers were identified with the help of Wynter-Blyth (1957). The nomenclature used is after Varshney (1983). The behaviour of visitors, the length of a visit and flowers visited in unit time using a stop watch were carefully studied. Four patches consisting of ten inflorescences each were marked at four study sites and visits were counted at half-an-hour intervals from 0600 to 1800 hours. The same procedure was repeated thrice on different dates. The more frequent visitors were caught and their bodies were examined under a stereomicroscope for the pollen adhering to body areas and then washed off with alcohol. The washings with a droplet of Lactophenol aniline-blue were observed for pollen under a light microscope.

RESULTS

1. **Blooming phenology**: The plants flower chiefly during July-December in conjunction with monsoon rains. During the summer months of March-May the plants defoliate and are leafless. With rains from mid-June, vegetative growth begins. Inflorescences arise on the newly formed branches. When water is available, it is not uncommon to find plants in flower outside the normal flowering season.

The racemose inflorescence is both axillary and terminal. Its length varies from 5-15 cm, consequently the number of flowers it bears varies from 31-123. It blooms for 11-19 days. Flowers usually mature in basipetal succession. The number of flowers produced per day per inflorescence varies from 1-9 (av. 4.2) as indicated by the observations on ten inflorescences. The average pattern of flower production did not reveal any specific trend.

2. **Phenology of anthesis**: On any day during the flowering life of an inflorescence, there is no uniformity in the maturation and anthesis of flower buds. Buds were seen opening round the clock. On a clear sky day, a mature bud takes 20-30 minutes to open fully. The temperatures during anthesis on the day of observation ranged between 26.3 - 30°C and relative humidity between 89-77%.

3. **Pollen characters**: Anthers dehisce just prior to anthesis by longitudinal slits. Grains, spheroidal, 30-35 µm in diameter, tricolporate, exine smooth and cytoplasm granular. Their number per anther ranged from 950-1210 and averaged 1060. They retained viability for 12 hr from anther dehiscence as indicated by their capability to set fruit in controlled experiments. Grains stored for 4 hr gave 64% fruit set, those for 6 hr 48%, 8 hr 20%, 10 hr 12%, and 12 hr 4%. Thereafter, there was no fruit setting. Pollen-ovule ratio came to 1060 : 1.

4. **Stigma receptivity**: Stigma remained receptive for 24 hr beginning with anthesis. On hand-pollinations 6 hr old stigmata gave 68% fruit set, 9 hr old ones 56%, 12 hr old ones 48%, 15 hr old ones 28%, 18 hr old ones 24%, 24 hr old ones 16%, still older stigmata were not receptive.

5. **Flower life-time**: Corolla persisted for about 48 hr after anthesis and then fell off along with stamens. Flower visitor activity caused the corolla to fall even earlier by 3-5 hr.

6. **Nectar dynamics**: Flowers secreted nectar continuously from the time they opened until the corolla dropped off. Nectar was secreted in measurable quantity on the first day, but it was negligible on the second day. Measurements at 3 hr intervals ranged from 0.3-1.0 µl. Sugar concentration ranged from 12-21%. Sucrose, glucose and fructose were present, the former being dominant. Proteins and amino acids were present; histidine scale was 4.0.

7. **Flower-visitor activity dynamics**: i) *Composition and abundance*: A total of 30 insect species foraged at the flowers (Table 1). Of these 11 are Hymenoptera (Apidae 3, Xylocopidae 2, Anthophoridae 4, Megachilidae 1, and Vespidae 1),

Table 1
PARTICULARS OF FLOWER-VISITORS ON
Duranta repens

Visitor species	Forage type		Body region of pollen deposition
	Pollen	Nectar	
HYMENOPTERA			
Apidae			
Apis cerana indica	+	—	Head, Proboscis
A. florea	+	—	"
Trigona sp.	+	—	"
Anthophoridae			
Amegilla sp.	+	+	"
Ceratina sp.	+	—	"
Thyreus histrio	+	—	"
Pithitis binghami	+	—	"
Xylocopidae			
Xylocopa latipes	+	+	"
X. pubescens	+	+	"
Megachilidae			
Megachile sp.	+	—	"
Vespidae			
Ropalidia spatulata	—	+	"
LEPIDOPTERA			
Sphingidae			
Macroglossum gyrans	—	+	Proboscis
Danaidae			
Danaus chrysippus	—	+	Proboscis, legs
Euploea core	—	+	"
Nymphalidae			
Euthalia garuda	—	+	"
Hypolimnas misippus	—	+	"
Precis lemonias	—	+	"
P. hierta	—	+	"
Phalanta phalantha	—	+	"
Acracidae			
Acraea violae	—	+	"
Papilionidae			
Atrophaneura hector	—	+	"
Papilio polytes romulus	—	+	"
P. demoleus	—	+	"
Graphium agamemnon	—	+	"
Pieridae			
Cephora nerissa	—	+	"
Catopsilia crocale pomona	—	+	"
C. pyranthe	—	+	"
Hesperiidae			
Barbo cinnara	—	+	"
Pelopidas methias	—	+	"

and the others Lepidoptera (1 Sphingid moth, 2 Danaids, 4 Nymphalids, 1 Acraeid, 4 Papilionids, 4 Pierids and 2 Hesperids). Apart from these flower visitors, a floriphagous beetle (*Mylabris pustulata*) was also observed. Lizards and spiders were seen waiting near the flowers to prey on the flower visiting butterflies and bees.

All the 30 species were not common to all the study sites (Table 2). Thus *Apis cerana indica, Amegilla* sp., *Thyreus histrio, Xylocopa* sp., *Macroglossum gyrans, Danaus chrysippus, Precis lemonias, Atrophaneura hector, Papilio polytes, Graphium agamemnon, Catopsilia pyranthe, Catopsilia crocale pomona, Barbo cinnara* and *Pelopidas mathias* were common to all the study sites. More constant and abundant of these visitors were *Apis cerana indica, Amegilla* sp., *M. gyrans, D. chrysippus, P. polytes, G. agamemnon, A. hector, C. pyranthe* and *C.c. pomona.*

Of the four groups of visitors, namely butterflies, bees, hawkmoths and wasps, the former dominated and their visits made up 49.75% of the total visits. Bees accounted for 34.75%, hawkmoth 14.5% and wasps 1.0%. At each of the four study sites, the same order of frequency of visits by different insect groups prevailed, of course, while their actual percentage of visits varied (Fig. 1).

ii) *Diurnal activity*: All the visitors listed in Table 2 are diurnal in their activity, and visited the flowers during 0600-1800 hr. Individual foragers exhibited peak activity in certain hours. On fine weather days *M. gyrans* exhibited stratification, visiting the flowers during two specified periods from 0600-0800 hr and again from 1600-1800 hr. But on cloudy days the visits were uniformly distributed over 0600-1800 hr. Thus the wild bee *Amegilla* sp. was more frequent during 0900-1300 hr, *A.c. indica* during 0900-1300 hr, *C.c. pomona* during 0800-1300 hr, *C. pyranthe* during 0900-1500 hr, *G. agamemnon* during 0800-1200 hr, *P. polytes* during 0600-0900 hr. and *A. hector* during 0600-1000 hr.

iii) *Flower visits per unit time and length of a visit*: Table 3 gives the data concerning length of a visit and total flowers visited per minute by different flower visitors. *M. gyrans, Amegilla* sp., *G.*

TABLE 2

CENSUS OF FLOWER VISITORS ON *D. repens* IN 1986 SEASON

	Site I			Site II			Site III			Site IV		
Insect species	18/7	28/7	1/9	14/7	26/7	31/8	16/7	29/7	3/9	10/10	25/10	3/11
BEES												
Apis cerana indica	315	439	114	299	486	209	845	919	436	66	216	314
A. florea	0	176	67	0	117	0	0	667	0	0	0	0
Ceratina sp.	42	102	0	0	0	0	109	159	771	98	205	0
Trigona sp.	0	0	0	73	80	20	0	0	0	0	0	72
Amegilla sp.	556	874	938	618	1,008	689	1,178	1,325	690	344	862	1,060
Thyreus histrio	0	152	238	0	64	60	239	340	186	0	197	0
Pithitis binghami	0	0	8	19	32	0	0	0	0	184	229	0
Xylocopa latipes	108	0	36	0	128	230	0	50	143	576	619	432
X. pubescens	0	0	0	0	110	192	0	78	98	457	603	512
Megachile sp.	0	185	340	0	0	186	0	0	0	163	205	0
WASP												
Ropalidia spatulata	25	38	77	29	44	162	0	51	30	0	0	0
MOTH												
Macroglossum gyrans	1,058	876	1,628	456	778	721	765	1,360	514	1,086	478	833
BUTTERFLIES												
Danaus chrysippus	367	89	7	155	67	78	111	131	87	11	84	234
Euploea core	0	141	0	62	44	61	71	142	69	0	0	0
Euthalia garuda	186	313	62	146	145	0	0	0	225	0	0	0
Hypolimnas misippus	0	0	23	0	0	20	0	0	0	36	52	0
Precis lemonias	126	0	0	83	71	37	0	201	0	11	0	198
P. hierta	19	27	0	22	20	0	0	0	0	0	0	0
Phalanta phalantha	0	46	0	60	0	47	0	0	0	0	0	0
Acraea violae	0	0	0	0	249	19	0	0	0	0	0	0
Atrophaneura hector	743	0	0	0	0	46	383	725	318	618	477	755
Papilio polytes romulus	716	428	248	307	546	402	422	562	290	97	254	658
P. demoleus	30	0	0	0	0	0	0	0	0	80	111	0
Graphium agamemnon	766	679	359	460	463	698	666	887	301	267	495	721
Cephora nerissa	63	0	34	0	116	0	0	0	0	0	0	0
Catopsilia pyranthe	631	760	131	609	931	783	496	630	487	187	574	972
C. crocale pomona	572	592	74	564	652	555	718	765	520	152	493	765
Eurema hecabe	0	214	0	73	103	0	59	0	49	0	0	0
Barbo cinnara	0	0	13	0	0	94	0	104	0	151	225	176
Pelopidas mathias	255	104	0	0	99	0	248	0	139	0	55	294
Total visits	6,578	6,235	4,397	4,035	6,353	5,309	6,310	9,096	5,353	4,594	6,434	7,996

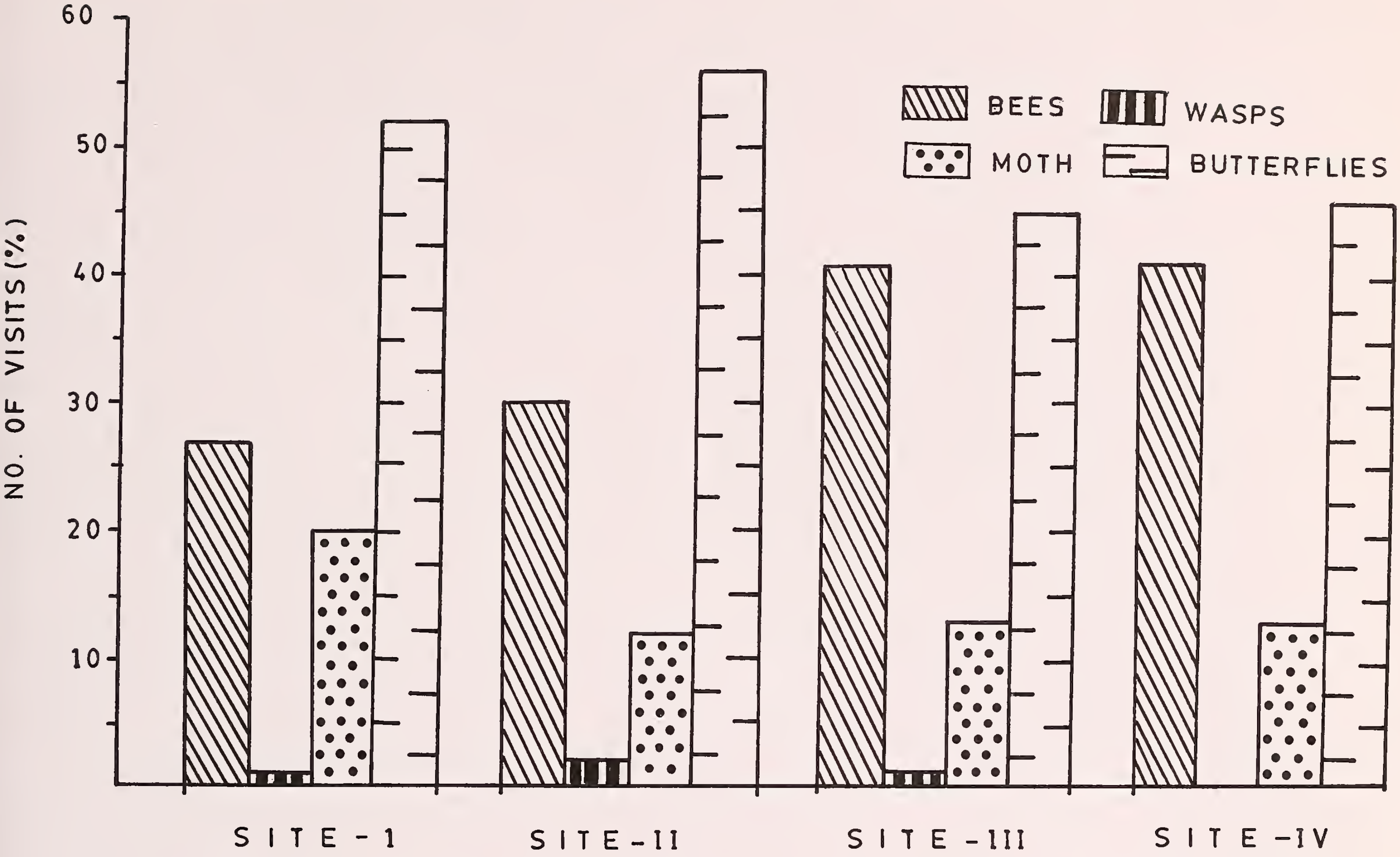

Fig. 1. Insect group abundance on *D. repens* flowers at different study sites.

agamemnon, P. polytes, and *A. hector* spent relatively less time at each flower and consequently covered a large number of flowers in unit time.

iv) *Insect behaviour at flowers*: The bees landed on corolla rim and probed for nectar. Then their head region touched the anthers. From the visual observations it was evident that the pollen collection and nectar gathering were not done in the same bout. *Amegilla* discriminated new from old flowers and visited mostly fresh flowers. *M. gyrans* while collecting nectar hovered at the flower, and probed the flowers in rapid succession. The butterflies were seen landing on the inflorescence for foraging. The papilionids characteristically fluttered while foraging. The proboscis and legs contacted the anthers and stigmas.

v) *Pollen transfer in the first visit by various visitors*: The amount of pollen removed from anthers and transfered to stigma in the first visit varied with different insect species. Of the 12 species for which such data were collected (Table 4), the efficiency order is descending from *Xylocopa, Amegilla, A.c. indica, P. polytes, G. agamemnon, A. hector* and *M. gyrans,* etc.

vi) *Pollen in body-washings of various flower visitors*: Of the nine species for which such data were collected, *Amegilla, Apis cerana indica, T. histrio, Ceratina* sp., and *P. polytes* carried relatively a larger number of pollen on their bodies (Table 5).

vii) *Pollen depletion from anthers vs. pollen deposition on stigmata under foragers activity*: Pollen-deposition could be related to pollen-depletion. During 0800-1200 hr there was 74% of pollen removal. In the same period pollen deposition was also high (Table 6). Both these events could be positively related to foragers activity which was high during this period.

viii) *Pollen loads on stigmata under lepidopteran activity*: Figures 2 and 3 give the

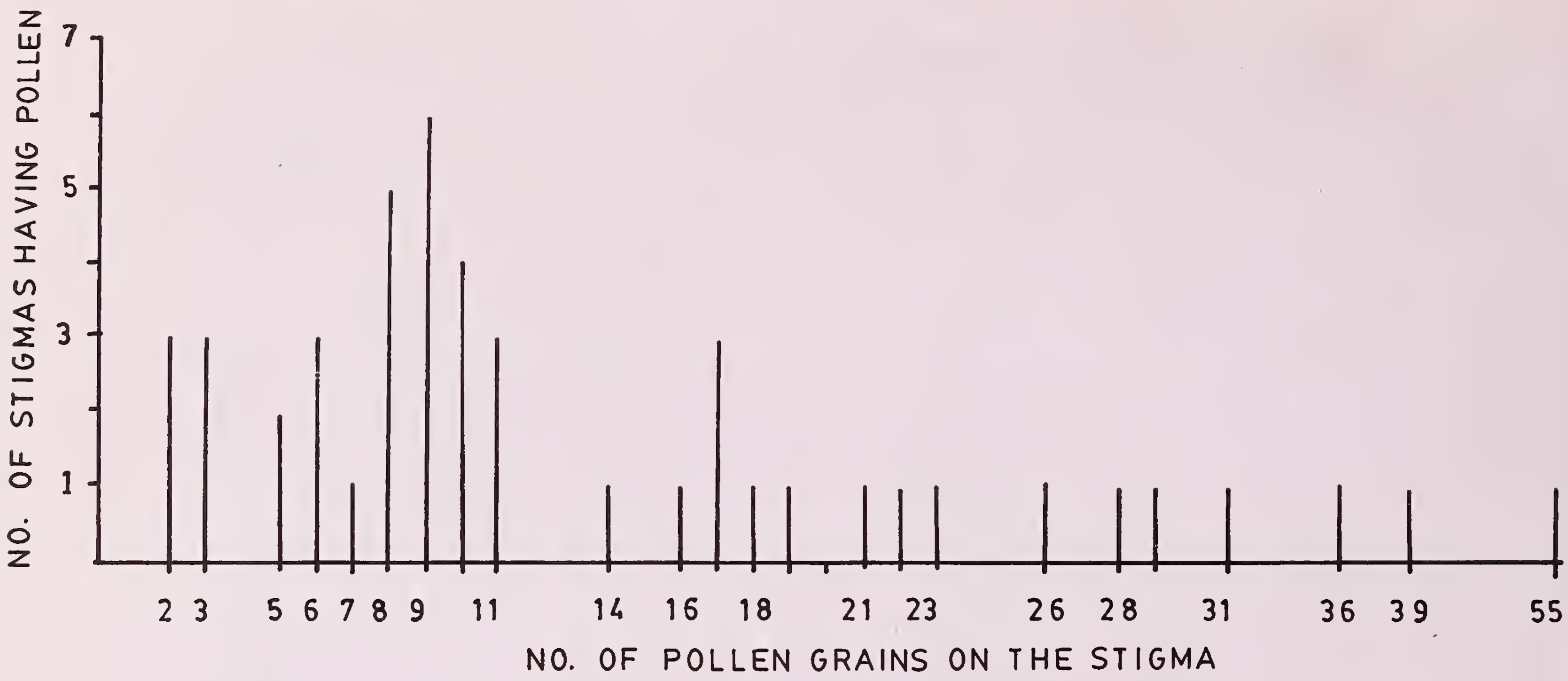

Fig. 2. Histogram diagram showing the frequency of stigmas having different number of pollen grains after hawkmoth visits.

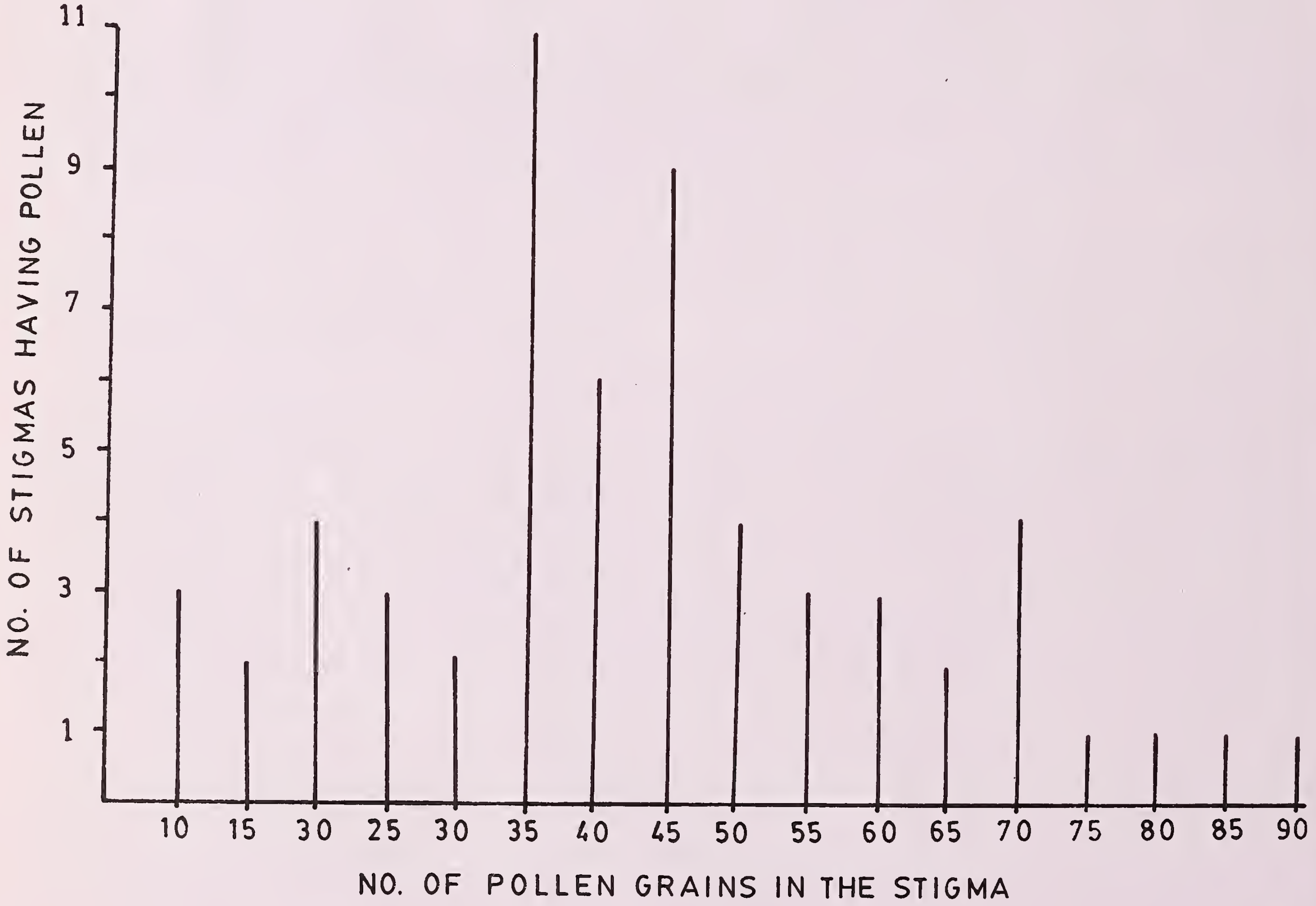

Fig. 3. Histogram diagram showing the frequency of stigmas having different number of pollen grains after butterfly visits.

Table 3

LENGTH OF A VISIT OF FORAGERS ON *Duranta repens* AND NUMBER OF VISITS IN UNIT TIME

Flower visitor	Sample size	Length of a visit in seconds		No. of flowers visited/minute	
		Range	Mean	Range	Mean
Apis cerana indica	5	2-5	4.0	13-27	15.0
A. florea	5	2-6	4.5	12-30	20.5
Ceratina sp.	5	2-7	5.0	12-23	17.0
Trigona sp.	5	3-5	4.0	17-23	19.0
Amegilla sp.	5	2-4	3.9	26-35	31.0
Thyreus histrio	5	2-7	5.5	12-22	20.0
Xylocopa latipes	5	7-12	9.0	5-10	7.0
X. pubescens	5	5-12	8.5	6-14	8.0
Ropalidia spatulata	5	1-3	2.5	37-49	42.0
Macroglossum gyrans	5	1-2	1.5	42-74	57.0
Danaus chrysippus	5	6-12	8.0	6-13	9.0
Euthalia garuda	5	7-20	13.5	10-20	16.0
Precis lemonias	5	3-14	7.0	3-9	6.0
P. hierta	5	3-12	6.0	5-20	13.0
Phalanta phalantha	5	6-14	9.0	8-13	10.0
Acraea violae	5	2-5	3.5	14-20	17.5
Atrophaneura hector	5	3-6	5.0	10-30	20.0
Papilio polytes romulus	5	3-9	4.0	6-20	13.0
Graphium agamemnon	5	1-5	2.0	36-52	40.0
Cephora nerissa	5	5-10	8.0	10-20	10.0
Catopsilia crocale pomona	5	4-8	6.0	5-15	8.0
C. pyranthe	5	4-9	6.0	4-15	8.0
Eurema hecabe	5	4-12	7.0	6-14	9.0

Table 4

POLLEN DEPLETION FROM ANTHERS *vs.* POLLEN DEPOSITION ON STIGMAS IN FIRST VISIT OF SOME FORAGERS ON *D. repens*

Name of the visitor	Mean no. of Pollen/flower after 1st visit	Pollen depletion (%)	Mean no. of pollen/stigma after 1st visit	Pollen deposition (%)
Apis cerana indica	3160	25	26	8
A. florea	3290	22	19	6
Amegilla sp.	2810	34	31	10
Thyreus histrio	3010	29	19	6
Xylocopa latipes	2410	43	52	16
X. pubescens	2200	48	61	20
Macroglossum gyrans	3710	13	23	6
Danaus chrysippus	4000	5	4	1
Atrophaneura hector	2540	16	21	6
Papilio p. romulus	3410	19	25	8
Graphium agamemnon	3610	15	24	8
Catopsilia c. pomona	3800	10	11	3
C. pyranthe	3920	7	8	2

Average number of pollen produced per flower = 4240.
Number of flowers sampled = 10.

number of pollen grains deposited on the stigmata after the flowers were visited by butterflies and hawkmoth. These stigmatic pollen loads are suggestive of the role of lepidopterans in the pollination of *Duranta repens* flowers.

ix) *Breeding systems*: Bagging experiments ruled out the presence of apomixis and autogamy. Out of the 50 flowers pollinated with geitonogamous pollen, 58% resulted in fruit set. The 50 flowers pollinated with xenogamous pollen gave 68% fruit set. In both cases, seed set was 100%. Thus xenogamy appears to be relatively more successful in this taxon.

x) *Natural fruit set:* In open pollination 37% fruit set was observed. Seed set and fecundity was 100% each.

Discussion

The flowers are hermaphrodite and homogamous. They are compatible with geitono-and-xeno pollen only. The flowers open at any time of the day. They are tubular (13 mm long) with a flat rim, always orienting upwards. They are visited during daytime by a number of insect species that included bees, a wasp, a hawkmoth and butterflies. The visitors are suitably rewarded with nectar and in case of bees pollen also formed part of the forage. These insects possess relatively long nectar collecting organs, namely tongues (bees and wasp) and proboscids (moth and butterflies) which enable them to manipulate the tubular corollas of *D. repens.* Further, the upward facing flowers with flat rims facilitated convenient landing of the foragers. The narrow tube with epipetalous stamens and introrse anthers facilitate the deposition of pollen on the proboscis of the foragers. Nine species out of the 30 species of foragers, namely the bees *A.c. indica,*

Table 5
POLLEN AMOUNTS IN BODY-WASHINGS OF DOMINANT FORAGERS ON *D. repens*

Name of the forager	Sample size	No. of pollen	
		Range	Mean
Apis cerana indica	5	27-66	51.0
Ceratina sp.	5	25-58	42.0
Amegilla sp.	5	35-62	57.0
Thyreus histrio	5	25-57	42.0
Danaus chrysippus	5	9-15	13.0
Atrophaneura hector	5	10-19	14.0
Papilio polytes romulus	5	10-25	19.0
Graphium agamemnon	5	13-33	19.0
Catopsilia crocale pomona	5	8-17	12.0
C. pyranthe	5	8-13	10.0

Amegilla sp., the diurnal moth *Macroglossum gyrans,* and the butterflies *Danaus chrysippus, Papilio polytes, Graphium agamemnon, Atrophaneura hector, Catopsilia crocale pomona, C. pyranthe* were constant and more frequent at all sites studied (Table 2). Of these *Amegilla, M. gyrans, P. polytes, G. agamemnon* and *A. hector* visited the flowers in rapid succession in short time (Table 3). They carried sufficient numbers of pollen on their proboscids (Table 5) and could transfer enough number of pollen on the stigma in their first visit (Table 4). Based on these observations they can be considered as the major pollinators of *D. repens.* Other foragers can also effect pollination, but their lower frequency of visits inconsistency, categorise them as minor pollinators.

The pollination that results from insect-visits may be geitonogamous and/or xenogamous. Foragers such as *Amegilla* sp., *Macroglossum gyrans,* the papilionid butterflies, and *Xylocopa* made frequent inter-population visits and could carry out xenogamous pollinations to a larger extent. In fact, xenogamy is a more successful mode of reproduction in this taxon.

An examination of the daily timing of foraging activity revealed that *Macroglossum gyrans* tended to avoid high temperatures by restricting its foraging time to the morning (0600-0800 hr) and to the evening (1600-1800 hr) hours. It appears that the foraging activity of *M. gyrans* is conditioned by weather factors as no such staggered activity was seen on a cloudy day.

Table 6
POLLEN-DEPLETION FROM ANTHERS *vs.* POLLEN-DEPOSITION ON STIGMAS OF *D. repens* UNDER FORAGERS ACTIVITY

Daily time (h)	No. of pollen depleted/ flower	Rate of pollen depletion (%)	No. of pollen deposited per stigma	Rate of pollen deposition (%)
0800	1180	31	64	25
1000	1040	27	53	21
1200	620	16	47	19
1400	560	14	33	13
1600	210	5	23	9
1800	250	7	30	13

Though opened flowers of *D. repens* are available all through the day no nocturnal visitors were noticed in the study area.

D. repens flowers are bluish in colour and are abundantly visited by butterflies. According to Baker *et al.* (1983), the butterfly flowers range from white to yellow, pink and even red, but not blue. Ilse and Vaidya (1956) stated that butterflies show a preference for blue colour. Not only the colours of *D. repens,* but other blue flowers of *Hyptis suaveolens* and *Stachytorpheta indica* in this locality are frequently and abundantly visited by butterflies. Our finding corroborates the views of Ilse and Vaidya but not Baker *et al.* The sucrose and amino acid rich nectar of *D. repens* comes under the category of nectars that are preferred by butterflies.

It may, therefore, be concluded that *Duranta repens* flowers are primarily meant for butterfly pollination. Next to butterflies the hawkmoth *M. gyrans* and the wild bees *Amegilla* sp. may be considered as the most effective users of *D. repens* floral resource in a mutualistic way.

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OCCURRENCE AND DISTRIBUTION OF SOFT CORALS (OCTOCORALLIA: ALCYONACEA) FROM THE ANDAMAN AND NICOBAR ISLANDS[1]

V. Jaya Sree, K.L. Bhat and A.H. Parulekar[2]

(*With a text-figure*)

Key words: Alcyonacea, soft corals, distribution, Andaman & Nicobar Islands, new record

Occurrence and new distributional records for 26 species of Alcyonaceans are given. These include 12 species of Sinularia, 6 of Lobophytum, 6 of Sarcophytum, one of Cladiella and one of Nephthea. Their ecological information on habitat and associations with the other organisms is also noted. A major factor limiting the distribution of soft corals is the availability of hard substratum for settlement. Other factors that determine their faunistic composition and abundance are correlated with resistance to harsh environments and life history parameters. Competitive interaction with other benthic reef-organisms also plays a major role in the distribution of soft corals in the Andaman and Nicobar Islands.

INTRODUCTION

Though studies on the systematics and distribution of Indian Ocean octocorals were initiated during the last century and have been continued to the present time knowledge on the group is scanty. In spite of the earlier surveys information on octocorals in some parts of the Indian Ocean is limited. These areas include certain remote island groups such as the Andaman and Nicobar Islands, as well as Lakshadweep, Mandapam area on the east coast and Sri Lanka. Apart from the "Investigator" Expedition collections (Thomson and Henderson 1906 and Thomson and Simpson 1909), a few reports mention soft corals in recent literature on Lakshadweep (Pratt 1903, 1905; Hickson 1903, 1905; Van of Wegen and Vennam 1991 and Alderslade and Prita 1991).

The Andaman and Nicobar Islands spread out in the Bay of Bengal between Lat. 6°45' N and 13°45' N and Long. 92°15' E and 94°0 'E have one of the richest coral reef formations with fringing reefs on the eastern side and barrier reefs on the western side (Anon. 1977, Pillai 1983, Tikader 1986). The present communication deals with the distribution and new records of soft corals in the Andaman Sea.

MATERIALS AND METHODS

Field observations were made and the soft corals were collected at windward reef at North Bay (depth 3-5 m), and Carbyn's Cove, Chiriatapu and Burmanaal (intertidal) and on the New Wandoor (3-5 m), western coast of south Andaman by surface snorkelling. At each locality, details of habitat type and water depth and other field conditions were recorded along with their quantitative availability. The material made available by the Institute of Chemical Technology (I.I.C.T.), Hyderabad and organic chemistry group of Andhra University, Waltair from the eastern side of Andaman from Mayabundar, Digilipur and Rangath (Intertidal) were also studied and included (Fig. 1). All the material, preserved in 70% ethanol, are deposited in the Marine Biology Museum and Taxonomy Reference Centre at the National Institute of Oceanography, Goa.

RESULTS AND DISCUSSION

Throughout the systematic account, references are often given just to major works such as Verseveldt (1970, 1971, 1980, 1982, 1983), Verseveldt and Benayahu (1983) and Tixier-Durivault (1945, 1951, 1956, 1958, 1966, 1970) from which the original specific descriptions can be traced.

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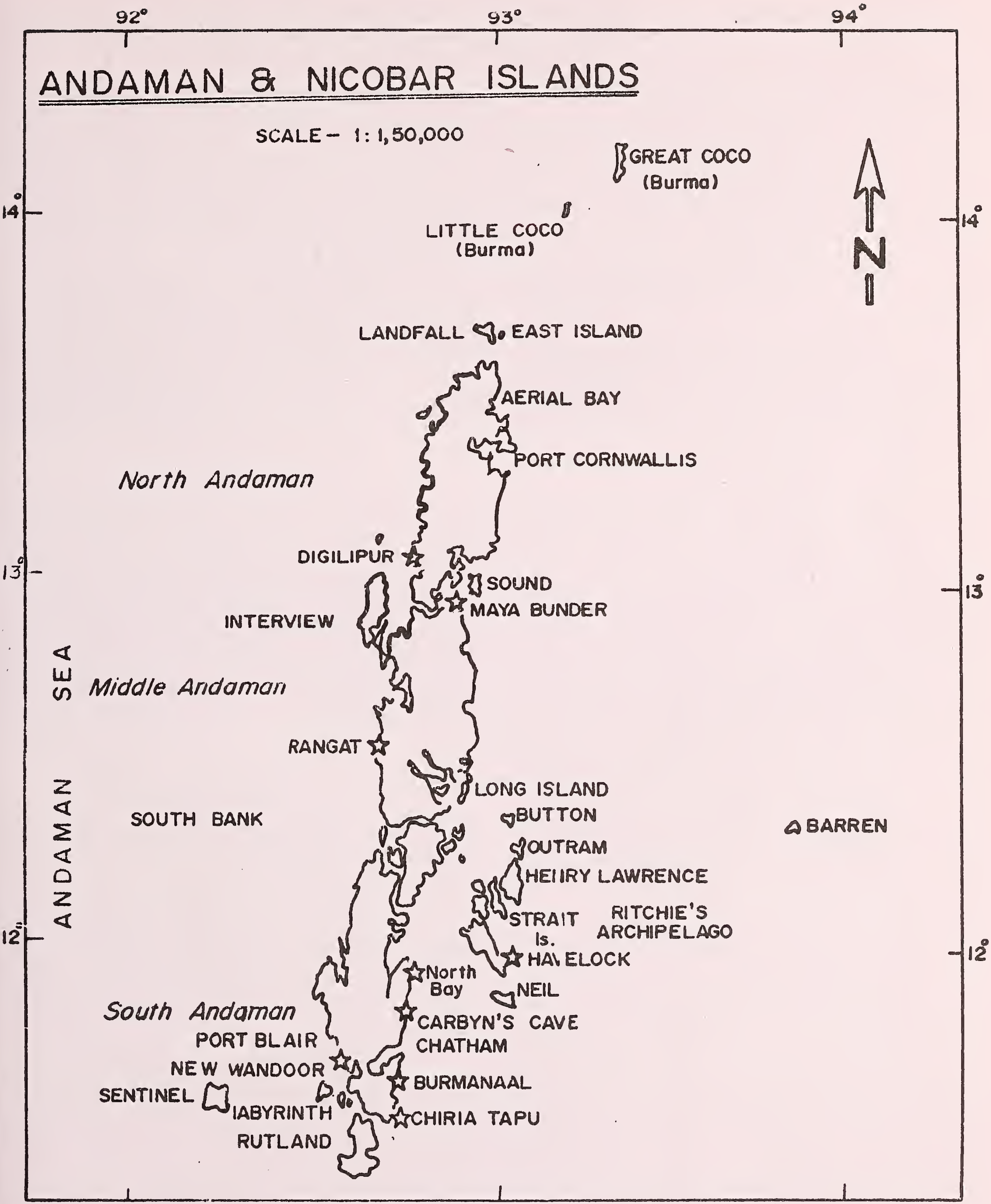
92°
93°
94°
ANDAMAN & NICOBAR ISLANDS
SCALE – 1: 1,50,000
GREAT COCO (Burma)
LITTLE COCO (Burma)
N
14°
13°
12°
LANDFALL
EAST ISLAND
AERIAL BAY
PORT CORNWALLIS
North Andaman
DIGILIPUR
SOUND
MAYA BUNDER
INTERVIEW
Middle Andaman
ANDAMAN SEA
RANGAT
LONG ISLAND
BUTTON
SOUTH BANK
BARREN
OUTRAM
HENRY LAWRENCE
STRAIT Is.
RITCHIE'S ARCHIPELAGO
HAVELOCK
North Bay
NEIL
South Andaman
CARBYN'S CAVE
CHATHAM
PORT BLAIR
NEW WANDOOR
BURMANAAL
SENTINEL
LABYRINTH
CHIRIA TAPU
RUTLAND

Fig. 1. Collection sites (☆) in Andaman Islands.

The collection chiefly comprises of 26 species of Alcyonaceans.

In addition, the species collected are of new geographical records found for the first time in this region. Table 1 presents the systematic account of the species with ecological information on habitat, faunistic composition and availability. The average temperature, salinity, pH and dissolved oxygen of the surrounding water are min. 25.5°C and max. 32.0°C, min. 30.51 ppt and max. 33.08 ppt, min. 7.71 and max. 8.54, min. 2.91 ml/l and max. 4.64 ml/l respectively.

This study shows that coral reefs of the Andaman and Nicobar Islands contain a diverse alcyonacean fauna. These comprise of *Sinularia, Sarcophytum, Lobophytum* and *Cladiella* characteristic of shallow reef habitats, such as reef flats and the upper fore reef zones. They usually create a monospecific carpet composed of numerous colonies, which locally may cover several square metres. The most abundant *Sinularia* in this study are *S. gibberosa, S. polydactyla.* The abundant *Lobophytum* are *Lobophytum strictum* and *L. pusillum. Cladiella pachyclados* is the most common species in all reef localities. Its colonies are usually found on the reef flats of Chiriatapu, Burmanaal, Carbyn's Cove and also found in the subtidal areas of North Bay. Similarly the genus *Sarcophyton* represented by the species *Sacrophyton trocheliophorum* is the most abundant soft coral. Colonies of this species create dense mats below the reef flats or on reef slopes (Wandoor, 2-5 m). Large colonies of *S. trocheliophorum* with a disc diameter of 50-80 cm, are a usual sight. *S. andamanensis,* a new species found during the current survey (Jayasree and Parulekar, in press) is widespread in the entire intertidal area of Carbyn's Cove. Most of these colonies bear small buds arising from the stalk. It is assumed that they detach from the colony and serve for asexual propagation. Also this species morphology shows that it has less abundance of sclerites, flexibility and hollow tubular nature of coenenchyme. These characters are quite essential for this intertidal soft coral, where there is less current and wave action, these can accumulate more water in their hollow interior so that they are not dessicated during low tides.

All 6 *Lobophytum* species are found in the subtidal waters. These colonies usually grow in the rocky crevices or between stony corals. The reason for the rarity of *L. panciflorum* at the reefs of Havelock, is due to the absence of rocks and over exploitation of stony corals by tourism and commercial activities.

Nephthea species inhabit mostly the depressions on reef flats at Chiriatapu and North Bay (2 m). The faunal characteristics of this region appear to be of the Indo-Pacific zoogeographical pattern. Most of the species have been described earlier from the Pacific Ocean (Verseveldt 1980, 1982 and 1983).

One of the most striking features of many alcyonaceans is patchy distribution (Benayahu and Loya 1977, 1981; Tursch and Tursch 1982). This feature may promote varied species composition and abundance in different localities. Such a spatial distribution results from the short pelagic phase of the planulae and their settlement (Benayahu and Loya 1984c). It is reported that asexual reproduction which is common in many soft corals may cause development of monospecific aggregations (Benayahu and Loya 1984b).

The important limiting factor for alcyonacean distribution is the availability of firm substratum suitable for larvae to settle. The present survey reveals that the soft coral assemblages at Andaman and Nicobar Islands are correlated with the suitable habitat and environmental factors (Dinesen 1983). Similar distribution of alcyoniid genera was recorded on reef flats off the Great Barrier Reef, Australia (Dinesen 1983).

Although the present survey lacks data on the soft coral diversity in deeper zones, it appears that in shallow waters of Andaman and Nicobar Islands soft corals are dominated by accumulations of numerous alcyoniids.

Competitive interactions with other reef organisms clearly play an important role in determining the distribution of soft corals (Benayahu

TABLE 1

SPECIES COMPOSITION, DISTRIBUTION AND ECOLOGICAL INFORMATION ON ANDAMAN ISLAND SOFT CORALS

	Species	Habitat & Depth	·Association	Availability	Month & Year of collection	Place of collection
Genus *Sinularia*, May, 1898						
1.	*Sinularia maxima* Verseveldt, 1971	Shallow, 1 m	Sponge, seaweeds mostly brown algae.	Frequent	March, 1992	Havelock
2.	*Sinularia ornata*, Tixier-Durivault, 1970	Intertidal	Seaweeds and sponge, *Tedania*.	Abundant	March, 1992	Havelock
3.	*Sinularia sandensis*, Verseveldt, 1977	Intertidal	Seaweeds and sponge, *Tedania*.	Frequent	March, 1992	Havelock
4.	*Sinularia manaarensis* Verseveldt, 1980	Intertidal	Seaweeds, *Holothuria scabra* and sponge, *Tedania*.	Frequent	March, 1992	Chiriatapu & Rangath
5.	*Sinularia depressa*, Tixier-Durivault, 1970	Intertidal	Living and non-living scleractinians, crabs and sponges.	Abundant	March, 1992	Mayabundar
6.	*Sinularia vrijmoethi* Verseveldt, 1977	Intertidal	Living and non-living scleractinians crabs and sponges.	Abundant	March, 1992	Mayabundar
7.	*Sinularia gibberosa* Tixier-Durivault, 1970	Sub-tidal (1-5 m)	Mostly non-living scleractinians and *Actinopyga mauritiana* and *Holothuria scabra*.	Abundant	November, 1991 March, 1992	Digilipur Havelock North Bay
8.	*Sinularia ovispiculata* Tixier-Durivault, 1970	Sub-tidal (2 m)	Living and non-living scleractinians, sponge, *Dysidea herbacea*.	Frequent	March, 1992	Digilipur
9.	*Sinularia granosa* Tixier-Durivault, 1970	Sub-tidal (2 m)	Living and non-living scleractinians, sponge, *Dysidea herbacea*.	Frequent	March, 1992	Digilipur
10.	*Sinularia flexibilis* (Quoy & Gaimard, 1833)	Sub-tidal (2 m)	Living and non-living scleractinians, sponges.	Frequent	March, 1992	Digilipur
11.	*Sinularia hirta* (Pratt, 1903)	Sub-tidal (2 m)	Living and non-living scleractinians, sponges and sea cucumbers.	Frequent	March, 1992	Digilipur Havelock
12.	*Sinularia polydactyla* (Ehrenberg, 1834)	Sub-tidal & Intertidal (1-3 m)	Sea-weeds and sea grasses.	Abundant	March, 1992	Havelock & Mayabundar

Species	Habitat & Depth	Association	Availability	Month & Year of collection	Place of collection
Genus: *Lobophytum* Von Marenzeller					
1. *Lobophytum pauciflorum* (Ehrenberg, 1834)	Sub-tidal (2 m)	Shrimps, fishes, sea-grasses and few living scleractinians.	Rare	November, 1991	Chiriatapu
2. *Lobophytum hirsutum* Tixier-Durivault, 1956	Intertidal	Living and non-living scleractinians, crabs and sponges.	Abundant	March, 1992	Mayabundar
3. *Lobophytum batarum* Moser, 1919	Sub-tidal (4 m)	Living scleractinians with sea lilies, sea cucumbers, giant clam fishes & occasional appearance of *Acanthester planci.*	Abundant	November, 1991	Wandoor
4. *Lobophytum pusillum* Tixier-Durivault, 1970	Sub-tidal	Living scleractinians with sea lilies, sea cucumbers, giant clam fishes & occasional appearance of *Acanthester planci.*	Abundant	November, 1991	Wandoor
5. *Lobophytum strictum* Tixier-Durivault, 1957	Sub-tidal & Intertidal (1-3 m)	Living scleractinians with sea lilies, sea cucumbers, giant clam fishes & occasional appearance of *Acanthester planci.*	Abundant	November, 1991	Wandoor, North Bay and Burmanaal
6. *Lobophytum catalai* Tixier-Durivault 1957	Sub-tidal (2 m)	Living and non-living scleractinians, sponge *Dysidea herbacea.*	Frequent	March, 1992	Digilipur
Genus: *Sarcophyton* Lesson, 1834					
1. *Sarcophyton trocheliophorum* Von Marenzeller, 1886	Intertidal Sub-tidal (2-5 m)	Living scleractinians and sea anemones.	Frequent	November, 1991 March, 1992	Carbyn's Cove & Digilipur
2. *Sarcophyton* elegans Moser, 1919	Sub-tidal (2 m)	Living and non-living scleractinians, sponges *Dysidea herbacea.*	Frequent	March, 1992	Digilipur
3. *Sarcophyton stellatum* Kukenthal, 1910	Sub-tidal (4 m)	Living scleractinians with sea lilies, sea cucumbers, giant clam fishes and occasional appearance of *Acanthester planci.*	Abundant	November, 1991	Wandoor

	Species	Habitat & Depth	Association	Availability	Month & Year of collection	Place of collection
4.	*Sarcophyton andamanensis* sp. nov.	Rocky Intertidal	Sea-anemone, *Radianthus* sp. , sea cucumber, *Holothuria scabra* and non-living scleractinians.	Rare	November, 1991	Carbyn's Cove and Chiriatapu
5.	*Sarcophyton buitendijki* Verseveldt, 1978	Intertidal	Non-living scleractinians, sea cucumbers, *Holothuria scabra.*	Abundant	March, 1992	Mayabundar
6.	*Sarcophyton crassocaule* Moser, 1919	Intertidal	Non-living scleractinians, sea cucumbers, *Holothuria scabra.*	Rare	November, 1991	Carbyn's Cove
Genus: *Cladiella* Gray, 1869						
1.	*Cladiella pachyclados* Klunzinger, 1877	Reef flats up to (3 m)	Seaweeds, sea cucumbers, *Holothuria scabra,* sponge-*Tedania.*	Abundant	November, 1991	Chiriatapu, Burmanaal and Carbyn's Cove
Genus: *Nephthea* Gray, 1862						
1.	*Nephthea* sp.	Reef flats & sub-tidal (2 m)	Seaweeds, sea cucumbers, *Holothuria scabra,* sponge-*Tedania.*	Abundant	November, 1991	Chiriatapu, North Bay

and Loya 1981, Sammarco *et al.* 1983). It is suggested that the abundance of alcyonaceans could be regulated by difference in life history parameters, mainly reproductive strategies (Benayahu 1985). Benayahu also reported that the rare occurrence of Nephtheids is due to their low reproductive potential and short distance dispersal of planulae. Life history studies on these soft corals would probably provide additional explanation for the distributional patterns of the various species. The alcyonarian fauna of the shallow reefs of Andaman and Nicobar Islands appear to be very rich, compared to the intertidal areas, being mostly prominent on places covered by living scleractinians or non-living scleractinians. It is reported, that in general when there are more living scleractinians, there are less alcyonaceans and vice-versa (Fishelson 1970).This selective occurrence of the two most important components of reef habitats seems to be controlled by environmental factors or by competition. The most important of these factors appear to be wave actions, the amount of sediment in the water and extreme low tides. Scleractinians are much more adapted to withstand wave actions, whereas alcyonaceans may be less sensitive to sedimentation.

Other associations are reef fishes such as pomacentrids, shrimps, sea cucumbers, *Holothuria scabra, Thelenata ananas* and *Actinopyga mauritiana,* sea anemone, *Stoichactis giganteum* with a symbiotic fish, *Amphiprion,* sponge, *Dysidea herbacea* and *Tedania* sp., crabs, seaweed mostly of brown, green algae and the sea grass *Thallassia* sp.

This preliminary survey leaves no doubt about the rich and highly diverse soft coral fauna of this geographical area though no quantitative comparative data are available as yet for other locations. It is suggested that further exploration would help us obtain new alcyonacean records.

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STUDIES ON CAPTIVE BREEDING OF THE GHARIAL, *GAVIALIS GANGETICUS* (GMELIN) IN ORISSA[1]

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Key words: gharial, captivity, breeding pool, courtship, mating, egg-laying, nests, clutch size, incubation & hatching, hatchlings

The gharial *Gavialis gangeticus* Gmelin bred in captivity for the first time at the Nandankanan Biological Park, Orissa in 1980. Since then, breeding of this species is a regular feature in the park. This paper embodies data on courtship, mating, egg-laying, nests, clutch size, incubation and hatching success recorded in the park during the fifteen year period from 1980 to 1994.

Introduction

The river Mahanadi and its tributaries in the State of Orissa are within the southern most limit of distribution of the gharial (*Gavialis gangeticus*), considered as an endangered species. Several attempts are being made in the country to save the species from extinction. Captive breeding is considered as one such attempt. The Government of Orissa (State Forest Department) has initiated a project on captive breeding of gharial at the Nandankanan Biological Park (the park lies within the geographical range of the species) with assistance from Government of India since 1975 - 76. The technical expertise for this project was provided by FAO / UNDP Consultant Dr. H.R. Bustard.

A large oval-shaped concrete breeding pool, with a capacity of 2.7 million litres was constructed inside the park. The pool measured 60 m at the longest part, 30 m at the widest part and had a depth of 9.15 m at its deepest. There was a 2.4 m sand bank with suitable riverine vegetation on one side of the enclosure for egg-laying and basking. The area was fenced with a 2 m high wall all around the area except 30 m on the viewers' side where a dry moat and a parapet 0.5 m high was provided.

The three near adult gharials, then available in the park, measuring 2.7 m (male), 2.5 and 2.65 m (females) were released into this breeding pool during February, 1976. Subsequently, four more sub-adult females measuring 2.3 m (one) and 1.5 to 1.8 m (three) were added in 1979 to this pool. In January, 1980, an adult male measuring 3.7 m received on breeding loan from the Frankfurt Zoological Society, Germany was added, increasing the breeding population to eight (2:6). Unfortunately, the resident male was killed by the Frankfurt male during the breeding season in February, 1980.

The first successful breeding of the Gharial was recorded in 1980 and since then, the species is breeding regularly. This paper records the observations made on aspects of breeding of the Gharial in the Nandankanan Biological Park, Orissa during the last fifteen years from 1980 to 1994.

Observations and Discussion

Courtship, mating and egg-laying: Courtship and mating of the gharials have been observed during the winter months (January and February) every year. All the 57 clutches of eggs laid by six female gharials during a period of 15 years (1980-1994) was recorded regularly during the month of March (8-30) only. According to Table 1 the first female laid only five clutches during eight years from 1980 to 1987 and no further egg-laying was recorded for this female from 1988 to 1994 (seven years). The second

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TABLE 1

YEAR OF EGG-LAYING : CLUTCH SIZE

Sl. No.	Particulars of Female Gharials	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total Number of eggs Laid (Total Number of Clutches)	Mean Clutch Size (Range of Clutch Size)
1.	First	25*	Nil	27	15	27	Nil	Nil	28	Nil	Nil	Nil	Nil	Nil	Nil	Nil	122 (5)	24.40 (15-28)
2.	Second	Nil	5*	28	14	28	29	31	26	32	32	36	38	39	Nil	Nil	338 (12)	28.17 (5-39)
3.	Third	Nil	Nil	Nil	5*	Nil	12	25	15	5	35	Nil	36	42	Nil	21	196 (9)	21.78 (5-42)
4.	Fourth	Nil	Nil	Nil	Nil	33*	32	32	37	42	34	39	39	31	51	26	396 (11)	36.00 (26-51)
5.	Fifth	Nil	Nil	Nil	Nil	29*	35	36	Nil	37	32	42	42	51	47	57	408 (10)	40.80 (29-57)
6.	Sixth	Nil	Nil	Nil	Nil	Nil	30*	33	34	2	46	38	50	44	47	48	372 (10)	37.20 (2-50)
	Total Number of Eggs (Number of Clutches)	25 (1)	5 (1)	55 (2)	34 (3)	117 (4)	138 (5)	157 (5)	140 (5)	118 (5)	179 (5)	155 (4)	205 (5)	207 (5)	145 (3)	152 (4)	1832 (57)	32.14 (2-57)

* Indicate first egg laying.

female laid 12 clutches of eggs from 1981 to 1992 continuously but egg-laying was not recorded during the subsequent two years (1993 and 1994). The third female laid nine clutches of eggs from 1983 to 1994 with no record of egg-laying during 1984, 1990 and 1993. The fourth female laid 11 clutches in 11 years from 1984 to 1994. The fifth female laid 10 clutches of eggs from 1984 to 1994 with no egg-laying during 1987. The sixth female laid 10 clutches of eggs continuously from 1985 to 1994. These observations suggest that annual egg-laying is not a regular feature in all the individual female gharials. It was not possible to ascertain the reasons of failure of the first female to lay eggs continuously for seven years since 1988. In no year, more than five female Gharials laid eggs. It is presumed that one male might not be able to mate with more than five females during each breeding season.

According to Whitaker and Basu (1982) mating of gharial takes place between December - January (the winter months) with low water levels and low temperatures. Mating occurs in water in cold weather months of December - January (Daniel 1983). He further states that the gharials nest in late March, early April and the nesting season does not vary by more than 10 days in any year and the females in an area nest more or less within a week. All the nine nests of 1976, located in the Narayani and Kali-Gandaki Rivers in Nepal were laid between 29th March to 21st April (Bustard 1980). No information on the frequency of egg-laying of individual gharials could be found in the available literature.

Nest: Observations on 28 nests of five egg-laying females were made between 1986 to 1991. The distance of the nest on the sand bank from the water's edge of the breeding pool varied from 5.71 m to 10.94 m (mean 8.02 m). The nests were pitcher shaped, diameter varying from 38 to 120 cm (mean 56.6 cm, n = 21 nests). The upper depth of the nest varied from 20 to 45 cm (mean 28.4 cm) and the lower depth of the nests varied from 33 to 70 cm (mean 45.04 cm). The eggs were laid in layers.

One of the nests in the Satkosia Gorge Sanctuary, Orissa was at a distance of 5.9 m from the water's edge at a height of 2.6 m above the water level (Singh and Bustard 1977). Whitaker and Basu (1982) stated that gharials dig their pitcher-shaped nest holes on steep sandy river banks at night and the average nest hole is 40 cm deep. The first layer of eggs in one clutch laid in Satkosia Gorge Sanctuary was 37.5 cm below the surface and the bottom 30 x 22.5 cm (Singh and Bustard 1977). The study of 28 nests in Chambal river revealed that nests were located at a distance of 4.6 to 14.5 m (mean 9.5 m) and at a height of 1.5 to 3.5 m (mean 2.4 m) from water (Whitaker and Basu 1982). They stated that three nests along Girwa river were situated 2.5 to 4.0 m (mean 3.2 m) and at a height of 1.0 to 3.0 m (mean 2.0 m). Nest depth varied from 30 to 37 cm with a width of 22 cm (Daniel 1983).

Clutch size: Table 1 shows that six female gharials laid 1832 eggs in 57 clutches from 1980 to 1994. The clutch size varied from 2 to 57 (mean 32.14). The clutch size of first female varied from 15 to 28 (mean 24.40); second female 5-39 eggs (mean 28.17); third female 5-42 eggs (mean 21.78); fourth female 26-51 eggs (mean 36.00); fifth female 29-57 eggs (mean 40.80) and sixth female 2-50 eggs (mean 37.20). Each female gharial laid a single clutch during each breeding season. There is great variation in clutch size of individual female gharials. More observations on the breeding biology of captive gharials are required to understand such variation.

The clutch size of eggs recorded in Narayani and Kali-Gandaki Rivers in Nepal in 1976 (nine nests) varied from 16 to 39 eggs (mean 25.5); in 1977 (16 nests) the range was 16 to 61 (mean 36.9) eggs and in 1978 (10 nests) the range was 18 to 45 (mean 31.0) eggs (Bustard 1980). The clutch size varies from 10 to 96 with an average of 40 eggs (Daniel 1983). The study of clutch size of gharial eggs of Girwa / Chambal Rivers in India and Rapti / Narayani Rivers in Nepal during 1976 to 1980 reveals that 3147 eggs were laid in 80 clutches with a mean of 39.30 eggs (range 18-95) (Whitaker and Basu 1982). According to Smith (1931), gharials lay about 40 or more eggs in sand banks.

Incubation and Hatching: The incubation period observed in 47 cases (date of egg laying to the date of hatching, both days inclusive) in nest varied from 55 to 79 days with a mean of 65.1 days. Similarly the incubation period observed in 44 cases in artificial hatchery varied from 57 to 89 days, with a mean of 71 days. This variation of incubation period recorded in different years may be due to the influence of local climatic factors. It is interesting to note that the incubation period observed in artificial hatchery was invariably longer than in natural nests. This might be due to the fluctuations in temperature during the process of translocation of eggs from natural nests to artificial hatchery.

Incubation period ranged from 72 to 92 days with a mean 84.5 days (Daniel 1983). According to Bustard (1980) the mean incubation period observed during 1976 and 1978 in Narayani and Kali-Gandaki Rivers in Nepal was 84 and 83 days, respectively, whereas the mean incubation period observed among 16 nests during 1977 in the same area was 94 days and this was attributed to low temperature existing in the natural sand bank in that year as a result of early April pre-monsoon shower at the time of egg laying, which persisted till the onset of the monsoons in June. Singh and Bustard (1977) stated that Gharial eggs incubated at Tikerpada in April-June, 1975 under artificial hatchery conditions, hatched after 71-76 days. Gharial nests on the Chambal took an average of 60 to 65 days to hatch (Whitaker and Basu 1982). Young gharials appear in March and April (Smith 1931).

Of 1832 eggs, 1046 eggs were allowed to incubate in natural nest and the rest 786 were shifted to an artificial hatchery about 50 m away for incubation. The eggs were shifted to the hatchery invariably during the second half of incubation period, i.e. from late April to early May.

In all, 576 hatchlings hatched during May and June (7 May to 11 June) out of 1046 eggs kept in the natural nest (55.07% hatching success), whereas 659 eggs have hatched (7 May to 15 June) out of 786 eggs kept in the artificial hatchery (83.84% hatching success). Thus, 1235 hatchlings hatched, out of total 1832 eggs laid (67.41% hatching success). The percentage of hatching was higher in hatchery in comparison to natural nest, which may be due to controlled temperature and moisture conditions in the hatchery.

The weight and measurements recorded in 49 newly hatched gharial hatchlings during the year 1986, 1990 and 1991 revealed that the hatchlings measured from 35 to 40 cm with mean of 37.35 cm including tail lengths of 18 to 21 cm (mean 19.6 cm). The weight ranged from 100 to 124 gm with a mean of 116.34 gm. According to Smith (1931) the newly hatched gharial hatchlings measure 375 mm. Hatchlings measured on an average 325-375 mm at birth with a weight range of 75-97 gm (Daniel 1983).

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CHEMICAL IMMOBILIZATION OF SMOOTH-COATED OTTER USING A COMBINATION OF KETAMINE AND XYLAZINE HYDROCHLORIDE[1]

S.A. Hussain, P.K. Malik and B.C. Choudhury[2]

Key words: Smooth-coated otter, *Lutra perspicillata,* immobilization, ketamine, xylazine

Two adult and three juvenile smooth- coated otters (*Lutra perspicillata*) were anaesthetized with Hellabrunn mixture (HBM) (400 mg of ketamine hydrochloride (KHCL) and 500 mg xylazine hydrochloride (XHCL). The mean dose of HBM used was 1.04 ml/otter or 15 mg of KHCL and 18 mg of XHCL/kg body weight. Induction time varied from 3-10 minutes and the duration of anaesthesia varied from 55-90 minutes. Long duration of sedation (2-11 hours) was observed in almost all the cases which can be attributed to xylazine hydrochloride. The experiment showed that HBM provided adequate immobilization of the smooth-coated otter for surgical manipulation.

INTRODUCTION

Several drugs have been used successfully to immobilize different species of otter. William and Kochner (1978) tested five anaesthetic agents (CI744, etorphine, fentanyl, ketamine hydrochloride and halothane) to establish a safe, effective and short acting anaesthetic dosage for use in sea otter (*Enhydra lutris*). Subsequently Williams and Siniff (1983) immobilized sea otter using fentanyl in combination with azaperone. Seal and Erickson (1969) and Seal *et al.* (1970) used phencyclidine and promazine to immobilize North American river otter (*Lutra canadensis*). Kane (1979) and Melquist and Hornocker (1979a,b) immobilized North American river otter with ketamine hydrochloride (KHCL). Hoover (1984) tried KHCL in combination with xylazine and acepromazine maleate for the general anaesthesia of American river otter. Jenkins and Gorman (1981), Reuther (1983), and Reuther and Brandes (1984) used KHCL for the immobilization of European otter (*Lutra lutra*) and Kane (1979) tried KHCL on the oriental small clawed otter (*Aonyx cinerea*). Reports on the chemical immobilization of smooth-coated otter (*Lutra perspicillata*) are, however, not available.

To implant radiotelemetric devices for an ecological study of the smooth-coated otter, it was imperative to select a safe, rapid and effective anaesthetic agent that could be easily administered and produced no undesirable side effects. A mixture of 400 mg of ketamine hydrochloride (KHCL) and 500 mg of xylazine hydrochloride (XHCL) - the Hellabrunn Mixture (HBM) - was chosen in the present study considering its safety margin. This paper presents effects of HBM on smooth-coated otters.

MATERIALS AND METHODS

Five smooth-coated otters (3 males and 2 females) were anaesthetized using HBM. The initial anaesthetic experiment and trial implantation were carried out on a captive adult male. Subsequently, two male otters (one adult and one juvenile) and two juvenile female otters, captured by using Tomahawk and leghold live traps in the National Chambal Sanctuary (NCS), were transported 40 km north-east to the field research station of the Wildlife Institute of India at Deori in the Morena district of Madhya Pradesh for surgery. Of the four wild otters caught, two were anaesthetized and implanted with radio-transmitters within 30 hours of capture. The other two otters were held for a period of 6 weeks in a cement pool and maintained on a live fish diet till surgery.

All the animals were kept off food for 8-10 hours prior to surgery. Each animal was then anaesthetized using a Teleinject blowpipe through

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a gas pressurized syringe filled with freshly prepared Hellabrunn Mixture HBM (ketamine hydrochloride 400 mg, Ketaset, Veterinary Products, Bristol Laboratories, Syracuse, New York, + xylazine hydrochloride 500 mg dry substrate, Rompun, Bayer Leverkusen, Germany).

The initial dose for the otters was calculated based on body weight and supplementary dosages were administered intramuscularly to achieve complete anaesthesia for surgery. Following administration of HBM, clinical signs and the timing of effects of drugs were recorded. During surgery, respiratory and heart rates were checked and changes or abnormalities were noted.

Induction time was recorded as the period between administration of the drug and failure of the animal to resist when handled. In the absence of suitable methods for measuring the duration and degree of anaesthesia, duration of anaesthesia was recorded as the interval from induction to the time when the animal regained ability to resist being handled and/or reacted to external stimuli. The total duration of sedation was recorded as the time when the animal completely gained consciousness and became normal. In order to allow for the completion of surgical procedure for radio-implantation, anaesthesia was maintained for a desirable period by supplementing with additional doses when required.

RESULTS

The mean dose of HBM required to anaesthetize was 1.04 ml/otter (± 0.143 range=0.5-1.3 ml) or 0.182 ml/kg body weight (± 0.024 ml/kg body weight, range=0.12-0.26 ml/kg) or 15 mg of KHCL and 18 mg of XHCL/kg body weight. The HBM produced immobilization and analgesia, with good muscular relaxation, adequate to perform surgery ranging from 55 to 90 minutes (Table 1).

Induction was achieved within 3-10 minutes (mean=6.4, ± 1.30 minute) after delivery of the drugs. In animals 1 and 3, a subsequent dose of 0.3 ml HBM was given intramuscularly to achieve induction. In case of animals 1 and 4, additional doses of 0.4 and 0.2 ml HBM respectively, were required to prolong the anaesthesia for completion of surgery. The duration of anaesthesia varied from 55-90 minutes (mean=68, ± 6.04 minutes). We did not find significant correlation between per kg dose of HBM and duration of anaesthesia (Spearman rank correlation, $r_s = 0.70$, $P>0.05$).

Following anaesthesia the heart rates and the respiratory rates decreased slightly, and then remained stable during surgery. In two cases slight muscular tremors were observed 10 to 15 minutes after induction and lasted for 20-30 seconds. During the anaesthesized period the eyelids remained open, muscle tone was normal and no muscular rigidity was observed at any stage. While recovering, control of the head was gained first, followed by fore and hind limbs. Otters were slightly aggressive during the early stage of recovery. Three animals urinated immediately after recovery from deep anaesthesia. On recovering from anaesthesia, the otters responded to slight noise and tactile stimuli, but they remained in a state of sedation for 2-11 hours (mean=5.4 hours, ± 1.63 hours).

However, 24 hours after surgery the captive adult male died. Necroscopy revealed that it had swallowed a piece of surgical rubber drape that had been spread in the cage, which blocked the trachea leading to asphyxiation and death.

DISCUSSION

Ketamine has been widely used to immobilize different species of otters, but it often causes muscle rigidity that hinders surgical procedure. Some mortality during anaesthetic procedure was also reported by William and Kochner (1978). Other effects included decline in body temperature, increased salivation, convulsions, depressed respiration and cardiac stimulation [Beck *et al.* (1971), Kolata and Rawlings (1982) cited in Logan *et al.* (1986)]. Besides, the use of ketamine alone in case of otters frequently results in hyperthermia in conjunction with poor relaxation, apnoea, tachycardia and hyperexcitability during the recovery phase (Seal and Kreeger 1987).

TABLE 1
DOSAGE AND TIMED OBSERVATIONS FOR FIVE SMOOTH COATED INDIAN OTTERS IMMOBILIZED WITH HELLABRUNN MIXTURE (400 mg KETAMINE HYDROCHLORIDE + 500 mg XYLAZINE HYDROCHLORIDE)

Case	Age & sex of otters	Wt. (kg)	Initial dose (ml)	Subsequent dose (ml)	Post induction Dose (ml)	Total dose (ml)	Induction time (min.)	Duration of anaesthesia (min.)	Duration of sedation (hr)
1.	Adult male (captive)	8.00	0.5	0.3	0.4	1.2	10	55	3
2.	Juvenile female	4.00	0.5	0	0	0.5	4	65	2
3.	Sub-adult male	7.50	1.0	0.3	0	1.3	8	60	4
4.	Juvenile female	4.45	1.0	0	0.2	1.2	7	90	11
5.	Juvenile male	4.55	1.0	0	0	1.0	3	70	7
	Mean	5.70	0.8			1.04	6.4	68	5.4
	Standard error of mean		±0.12			±0.14	±1.29	±6.04	±1.63

Alternatively, ketamine can be easily administered, is readily effective, has a wide margin of safety and its effects are not cumulative as those of barbiturate, therefore the doses can be frequently repeated (Ramsden *et al.* 1976, Melquist and Hornocker 1979a,b).

Ketamine when used in combination with xylazine, another central nervous system depressant that produces analgesia with sedation and muscle relaxation [Hebert and McFetridge (1981) cited in Logan *et al.* (1986)] causes reduction in salivation, muscle rigidity, emesis and convulsions (McWade 1982). To eliminate the side effects of ketamine anaesthesia, acepromazine, oxymorphine, trifluromazine and xylazine are used in fields (Amend 1972, Herbst *et al.* 1985, Logan *et al.* 1986). Apart from this the combination of KHCL and XHCL has been used to immobilize many other carnivores (e.g. Stephenson *et al.* 1978, Knight 1980, Hebert and McFetridge 1981, Parry *et al.* 1981, Nielsen *et al.* 1982, Herbst *et al.* 1985, Kreeger *et al.* 1986, Terry *et al.* 1986). These drugs usually result in smooth induction and recovery (Harthroon 1976). Thus, Seal and Kreeger (1987) recommended the use of ketamine (15 mg/kg) and xylazine (1 mg/kg) as the safe anaesthetic agent for otters. In this study we have used Hellabrunn Mixture which has a specific combination ratio (1:1.25) of ketamine and xylazine.

Xylazine often causes prolonged sedation (Parry *et al.* 1981, Hatch *et al.* 1982) that can be eliminated by using yohimbine hydrochloride, an antagonist to XHCL (Hatch *et al.* 1982, Cronin *et al.* 1983; Goldberg and Robertson 1983, Jessup *et al.* 1983). In our experiment we observed prolonged sedation (2-11 hr) that could be attributed to XHCL. The duration of sedation could have been altered at least in the fourth and fifth cases.

There is evidence that drug choice, drug dose and animal response differ among species and may vary within species (Seal and Kreeger 1987). Even though the dose/kg body weight varied considerably we did not find significant variation in duration of anaesthesia. This may be due to the small sample size and various age and sex of otters. The variation in initial drug dose in the two juvenile females appears to be due to temperament of the otters just before administration of the drugs. One of the juvenile females (case 4) was agitated when compared to the other (case 2). Both the adult males took longer time to achieve induction compared to the juvenile male (case 5) and juvenile female (case 2). Except for longer duration of sedation no other physiological complication such as nausea, muscle rigidity, and apnoea were observed. The urination in most cases might have been due to the xylazine induced hyperglycaemia. In this study we could have reduced the long sedation period by using yohimbine, but it was not available to us.

From the experiment we conclude that Hellabrunn Mixture is a safe anaesthetic agent for otters. However, to eliminate the side effects of xylazine, yohimbine hydrochloride can be administered. Care should be taken to keep the animal preferably in a clean wooden squeeze cage avoiding surgical drapes and polyethylene sheets.

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CHECKLIST OF THE BIRDS OF THE DELHI REGION: AN UPDATE[1]

SUDHIR VYAS[2]

(*With a text-figure*)

Key Words: Delhi, birds, *Porzana porzana, Charadrius asiaticus, Surniculus lugubris, Prinia flaviventris, Megalurus palustris, Saxicola leucura*

A complete list of birds recorded from the Delhi region during two separate periods, 1977-79 and 1984-86, is compared with previous checklists. The comparison reveals changes in status and populations of various species, notably sharp declines for many resident raptors (such as Crested Honey Buzzard, White-eyed Buzzard, Tawny Eagle, Pallas's Fishing Eagle, King Vulture, Laggar Falcon, Red-headed Merlin and Dusky Eagle-Owl), several riverside species (Blacknecked Stork, Greater Adjutant, Great Stone Plover, Little Tern and Indian Skimmer) and some passerines (Marshall's Iora, White-browed Fantail Flycatcher, Paradise Flycatcher, Chestnut-bellied Nuthatch, White-bellied Minivet, Spotted Grey Creeper and wintering Wheatears). Six additions to the Delhi checklist are recorded, including three breeders (Spotted Crake, Caspian Plover, Drongo-Cuckoo, Yellowbellied Wren-Warbler (breeder), Striated Marsh Warbler (breeder), Whitetailed Bush Chat (breeder).

INTRODUCTION

A checklist of the birds of the Delhi region was first attempted by Basil-Edwards (1926) and later, Frome (1947, 1948) prepared a second checklist covering the period 1931-45. Subsequent additions to the list were made by Benthall (1949) and Alexander (1949). More recent checklists are based on Hutson's observations in 1943-45, which, supplemented by Alexander's records, were published in book form, Hutson (1954); and on relatively intensive field work in this area over the years 1958-70 by several ornithologists (Malcolm MacDonald, Julian P. Donahue, Victor C. Martin, Peter Jackson, Usha Ganguli, etc. - collated in Usha Ganguli's Guide to the Birds of the Delhi Area, 1975). Abdulali and Panday's (1978) Checklist of the Birds of Delhi, Agra and Bharatpur is the latest and most comprehensive of these checklists available.

Since all these comment to one extent or the other on the status, populations and habitat preferences of the various species, they are of interest in their illustration of how Delhi's bird life has evolved along with the city itself. Indeed, it appears that with the creation of new habitats, and the protection accorded to certain patches of habitat (river, scrub, garden or forest) within the city's limits, both avian diversity and numbers of many species actually increased uptil the 1960s. Thereafter, judging from personal observations in the late 1970s and mid 1980s, increasing urbanisation in South Delhi and east across the Jamuna river has destroyed, or blocked access, to some of the best bird habitats and resulted in the decline of some species; at the same time, there has also been new colonisation by a few species, such as two marsh haunting warblers (Yellow-bellied Wren-Warbler, Striated Marsh Warbler) and a thrush (White-tailed Bush-Chat).

METHODOLOGY

Records of bird observations were maintained during two separate periods of residence in Delhi, from end 1977 to September 1979 and from end-1984 to July 1986. Compared, in particular, with the status notes recorded by Usha Ganguli, these observations provide some indication of how Delhi's birds have fared since the early 1970s.

The area covered was not, however, as extensive as that covered by the earlier studies; it includes essentially the following habitats: (i) the Jamuna river, with its associated cultivated and

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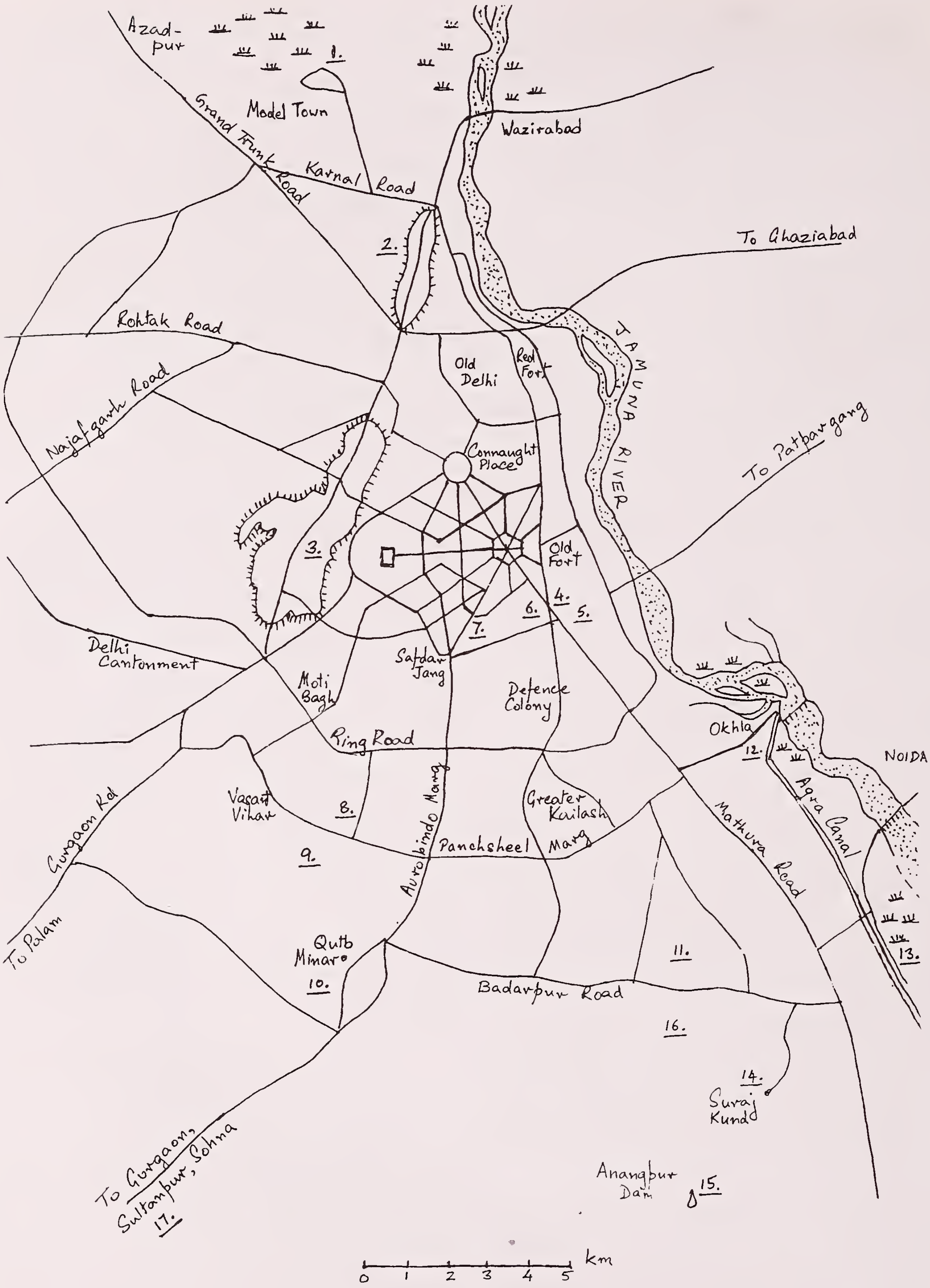
Azad-pur
1.
Model Town
Grand Trunk Road
Karnal Road
Wazirabad
2.
To Ghaziabad
Rohtak Road
Old Delhi
Red Fort
JAMUNA RIVER
Najafgarh Road
Connaught Place
To Patpargang
3.
Old Fort
4.
5.
6.
7.
Safdar Jang
Delhi Cantonment
Moti Bagh
Defence Colony
Okhla
12.
NOIDA
Ring Road
Vasant Vihar
8.
Aurobindo Marg
Greater Kailash
Agra Canal
Mathura Road
Panchsheel Marg
9.
Gurgaon Rd
To Palam
Qutb Minar
10.
11.
13.
Badarpur Road
16.
14.
Suraj Kund
Anangpur Dam
15.
To Gurgaon, Sultanpur, Sohna
17.
0 1 2 3 4 5 km

Fig. 1. Sketch map of the immediate neighbourhood of Delhi. Birdwatching Sites indicated on the map. 1. Marshes near the Coronation Memorial Pillar and Model Town, North Delhi; 2. Old Delhi (Northern) Ridge; 3. New Delhi (Southern) Ridge; 4. Delhi Zoo; 5. Sunder Nursery, Humayun's Tomb area; 6. New Delhi Golf Links; 7. Lodi Gardens; 8. Hauz Khas 'city forest'; 9. Jawaharlal Nehru University Campus; 10. Qutub Minar and associated ruins, Mehrauli; 11. Tughlakabad; 12. Okhla; 13. Madanpur marshes, between Agra Canal and the river; 14. Surajkund; 15. Anangpur Dam; 16. Scrub country near Tughlakabad; 17. Road to Gurgaon, Sultanpur, Sohna, Nuh.

marshy areas, from Wazirabad in North Delhi to about 6 km south of Okhla; (ii) New Delhi, including parks and the artificial city forests of South Delhi; (iii) the marshes near the Coronation Pillar and Model Town in North Delhi; (iv) the New Delhi Ridge, and the associated thorn-scrub country extending southwards past the Jawaharlal Nehru University campus to the Qutub Minar/Mehrauli area and east to Tughlakabad and Surajkund; (v) scrubby rocky areas near Sohna, south of Delhi, and (vi) the Sultanpur Lakes and countryside near Gurgaon, southwest of Delhi. West Delhi and the Najafgarh area, and the now rapidly colonising countryside across the Jamuna river were neglected completely. The sketch map of Delhi's immediate neighbourhood (Fig. 1) indicates most of these sites.

Observations were taken during field trips as and when time permitted, and did not follow any pattern or periodicity. No collecting or netting was done.

BIRD LIST

In the list of species recorded by me, I have included comments where my observations differ from Ganguli (1975) and Abdulali and Panday's (1978) Checklists.

The following symbols are used in attempting to define the status of each species;

R: Resident (seen all year).

RB: Resident, breeding confirmed.

W: Winter visitor.

IW: Irregular winter visitor (not annual).

M: Migrant, in seasons other than winter.

PM: Passage migrant (both passages, unless specified).

V: Vagrant.

The following symbols attempt to define the population of the species, in the appropriate season of occurrence:

a: Abundant, in large numbers in the right habitat.

c: Common, will usually be found in the right habitat.

fc: Fairly common, or regularly (but not always) seen in the right habitat.

o: Occasional, not expected to occur, even in the right habitat.

s: Scarce, less than a couple of records each season.

r: Rare.

001. Little Grebe, **Tachybaptus ruficollis** - R, c.

002. Great Crested Grebe, **Podiceps cristatus** - W, o. A few records in winter, all of single birds, on the Jamuna river and Sultanpur lakes.

003. Rosy Pelican, **Pelecanus onocrotalus** - W, c. Sultanpur Lake; numbers vary from year to year; maximum of 400 in winter 77-78, over 1000 in winter 78-79, very few (less than 20) in winter 85-86. A few present with Dalmatian Pelicans at Okhla in March 1979.

004. Dalmatian Pelican, **Pelecanus crispus** - W, fc. Few each winter at Sultanpur, maximum of about 15 (not in one flock) in March 1986. Dalmatians, with a maximum of 17 on 7 March 1979, are often present just downstream of the Okhla weir on the Jamuna in March, when the gates of the weir are opened, presumably resulting in an abundance of fish below the gates.

005. Large Cormorant, **Phalacrocorax carbo** - RB, fc.

006. Indian Shag, **Phalacrocorax fuscicollis** - RB, fc.

007. Little Cormorant, **Phalacrocorax niger** - RB, c.

008. Indian Darter, **Anhinga rufa** - R, fc.

All the above four species are doing well. Large Cormorants and Shags appear to have increased since Usha Ganguli’s time, with 100-400 present at Sultanpur in winter. Flights to roosts of Large Cormorants north along the river at Okhla in summer may total several hundred. Shags breed with Little Cormorants at Delhi zoo; Large Cormorants on acacia covered islands in Sultanpur Lake.

009. Grey Heron, **Ardea cinerea** - RB, fc. Small numbers, breeding locally.

010. Purple Heron, **Ardea purpurea** - RB, c. Very common at Okhla, May-September. Breeding in reedbeds at Madanpur village, south of Okhla;

about 40 nests on 6 July 1986. Nests contained well grown young; a few fledged juveniles hunting on short grass but flying back to nest on parent's return. More birds probably breed on reedy islands at Okhla. The increase in the populations of this species noted by Usha Ganguli appears to have been maintained.

011. Little Green Heron, **Butorides striatus** - R, s. Only noted at Surajkund, where present all year. Some wandering after breeding, indicated by one juvenile seen in Delhi zoo, August 1984.

012. Indian Pond Heron, **Ardeola grayii** - RB, c.

013. Cattle Egret, **Bubulcus ibis** - RB, a.

014. Large Egret, **Egretta alba** - RB, c.

015. Smaller Egret, **Egretta intermedia** - RB, c.

016. Little Egret, **Egretta garzetta** - RB, c.

017. Night Heron, **Nycticorax nycticorax** - RB, c.

All the above six species evidently doing well, breeding locally.

018. Chestnut Bittern, **Ixobrychus cinnamomeus** - M(or R?), o.

019. Yellow Bittern, **Ixobrychus sinensis** - M(or R?), s.

Both bitterns were recorded from early June onwards through the monsoon at Madanpur and Okhla, the former also at marshes in North Delhi. Pairs of both species seen flying back and forth high over reedbeds at Okhla with slow flapping flight. The Chestnut Bittern appears the commoner of the two.

020. Painted Stork, **Mycteria leucocephala** - RB, c. Has maintained its abundance. Breeding freely in Delhi zoo. Often large gatherings during the monsoon by the river, maximum of 250 in July 1985.

021. Openbill Stork, **Anastomus oscitans** - M, o. Remains unusual, though rather more frequent than what the few records in the 1960s and 1970s appear to indicate. A few present every year March to August about Okhla and elsewhere, with a maximum of 32 on 7 March 1979 at Okhla.

022. Whitenecked Stork, **Ciconia episcopus** - RB, fc. Fairly common, frequent records of pairs or small parties, in cultivation by the river, marshy areas near Model Town in North Delhi and open country about Gurgaon and Sultanpur. No noticeable change in status or population.

023. Blacknecked Stork, **Ephipporhynchus asiaticus** - R, s. Appears to have declined since the 1970s, when it was considered fairly common by Usha Ganguli. One pair usually present at Sultanpur Lake, and a single bird on a Jamuna sandbank in March 1979 are the only records. No evidence of breeding.

024. Adjutant Stork, **Leptoptilos dubius** - M, s. Up to 4-5 birds present in July-August by the river about Okhla nearly every year. No evidence of the large congregations recorded by Usha Ganguli in the 1960s.

025. White Ibis, **Threskiornis melanocephala** - R, fc. Seen only at Sultanpur Lake, maximum of about 30 birds on a given day. Numbers may have declined.

026. Black Ibis, **Pseudibis papillosa** - RB, o. Scattered pairs or parties of up to 6, by the river and at Sultanpur. Breeding recorded in July 1986; pair building nest on an unusual site, on the crossed steel struts, at a height of about 30 m, of a giant power pylon standing in an open field at Madanpur, south of Okhla. Building material was carried by only one of the pair, the other following the former on each visit to the nest site. Observations could not be continued to determine whether breeding was successful.

027. Spoonbill, **Platalea leucordia** - R, fc. No evidence of breeding, but remains in good numbers throughout the year, both at Sultanpur and by the river; numbers increase December to March.

028. Greater Flamingo, **Phoenicopterus roseus** - R?, fc. Up to 200-500 birds present at Sultanpur usually, all year, but numbers vary irregularly; at times, up to 1500. In 1985 and 1986 birds were for the first time seen by the Jamuna river, up to 200 between March and June with smaller numbers till October.

029. Whitefronted Goose, **Anser albifrons** - V. 1 immature, associating with Spotbills (rather than with nearby parties of Greylag) was present at

Okhla on 21 January 1986.

030. Greylag Goose, **Anser anser** - W, c. Probably under 500 at Sultanpur each winter, except in December 1985, when over 1000. Very occasionally seen by the river.

031. Barheaded Goose, **Anser indicus** - W, c. May have increased in the Delhi area and is now commoner than the Greylag. Minimum of 1500-2000 at Sultanpur in winter 1985-86. Much more frequent by the river than the Greylag, with parties of 10-20 often present at Okhla in midwinter. Numbers increase (passage?) in March, with a maximum of 150 on 2 March 1986 on Okhla sandbanks.

032. Lesser Whistling Teal, **Dendrocygna javanica** - M(Breeding?), o. Not recorded 1978-79, but up to 25 were present during May 1985 and between 20 April - August 1986 about Okhla. On 6 July 1986, pairs and foursomes were seen flying about and settling in reedbeds at Madanpur - indication of nesting activity? On 5 August 1989, 6-7 pairs were noted flying out from small islets in the Okhla reservoir towards surrounding fields. In comparison with the few earlier records, this species appears to have increased and is possibly breeding in the area.

033. Ruddy Shelduck, **Tadorna ferruginea** - W, c. Maximum of 250 on the 8 km stretch of river from Old Delhi to south of Okhla.

034. Common Shelduck, **Tadorna tadorna** - IW, s. Maximum of 9 birds present on the Jamuna river through 1979. 5 seen at Sultanpur on 28 December 1985.

Most of the ducks appear to have maintained their numbers in spite of increasing urbanisation on the east bank of the river. The large numbers which were noted wintering on the river north of the old Okhla weir in 1978-79 appeared to have shifted their main resting area to just downstream, where the new Okhla barrage has resulted in the impoundment of a large body during the monsoon, which remains until midwinter when dessication sets in.

035. Pintail, **Anas acuta** - W, a. With Shoveller, the commonest duck in winter. On the river, maximum of 6000 on a 6 km stretch; at Sultanpur, maximum of 5000 in December 1985.

036. Common Teal, **Anas crecca** - W, c.

037. Spotbill, **Anas poecilorhyncha** - RB, c. Populations may have increased since the 1960s-70s. Maximum numbers during end March-August. Over 2000 counted in two hours on feeding flights on a late May evening at Okhla. Breeding freely, ducklings noted May-August. Wild birds breeding at Delhi zoo.

038. Mallard, **Anas platyrhynchos** - W, o. Maximum of 30 at Sultanpur on 1 March 1986.

039. Gadwall, **Anas strepera** - W, c. In smaller numbers than the Pintail.

040. Falcated Teal, **Anas falcata** - V. At least one male with Gadwall at Okhla on 2 February 1979.

041. Wigeon, **Anas penelope** - W, c. Maximum in 100s on the river and Sultanpur.

042. Garganey, **Anas querquedula** - PM, c. Both passages, abundant in spring, 8 March-24 May.

043. Shoveller, **Anas clypeata** - W, a.

044. Redcrested Pochard, **Netta rufina** - W, fc. Maximum of under 250 in winter, usually only in 10s on the river and Sultanpur.

045. Common Pochard, **Aythya ferina** - W, c. Maximum of 2000 on the river.

046. White-eyed Pochard, **Aythya nyroca** - W, fc. Small numbers only, 10s rather than 100s.

047. Tufted Pochard, **Aythya fuligula** - W, c. At times outnumbering all other Pochards on the river, as in winter 1985-86.

048. Cotton Teal, **Nettapus coromandelianus** - M, o. Small numbers only, March to August. Maximum of about 30 in water lily covered borrowpit in August 1989. No evidence of breeding.

049. Nukta, **Sarkidiornis melanotos** - M, s. Mostly recorded in summer, late March to June. Maximum of 28 seen returning to daytime rest area on the river on a late May morning.

050. Blackwinged Kite, **Elanus caeruleus** - RB, fc. Thinly scattered in open areas, even within city limits (e.g. New Delhi Ridge). Flying young accompanying parents at the end of December 1985.

051. Crested Honey Buzzard, **Pernis**

ptilorhynchus - R? s. Has declined since the 1960s. A pair in December 1985 at Mehrauli, another pair which haunted the New Delhi Ridge in March-May 1986, and an immature which descended to an Okhla sandbank to drink on a hot early morning on 17 May 1986 are my only records in this entire period!

052. Pariah Kite, **Milvus migrans** - RB, a. The race *govinda* is an abundant breeding resident; the race *lineatus* is occasionally seen in winter.

053. Brahminy Kite, **Haliastur indus** - M, s. May have declined in the area. Singles at the Delhi zoo in August, and 2 immatures at Okhla in July 1985 are the only records.

054. Shikra, **Accipiter badius** - RB, c. Nest building in second-half of March, feeding newly hatched young in May, at Lodi Gardens, 1986.

055. Sparrow Hawk, **Accipiter nisus** - V (or IW?), r. A female in January 1979 seen within city limits is the only record.

056. Longlegged Buzzard, **Buteo rufinus** - W, fc. Well distributed in winter, even within and over the city. Most birds tend towards the pale phase, but one classic dark phase bird was recorded by the river at Madanpur on 19 January 1986. May have become actually more common since the 1960s.

057. White-eyed Buzzard, **Butastur teesa** - R? s. Appears to have declined and is now distinctly scarce. Occasional sightings near the river and Tughlakabad in 1978-79; a pair at Palam in September 1985 and one bird in Sunder Nursery within city limits in March 1986 are the only records.

058. Booted Hawk-Eagle, **Hieraetus pennatus** - W, o. Usually singly, once a pair seen in March 1986. Only about 1 in 5 appear to be of the pale phase; the dark phase and an occasional intermediate phase are more frequent. The intermediate phase has the typically patterned upper parts of this species, including the pure white shoulder-spot; the throat and breast are dark buff-brown, the belly paler; lesser underwing coverts medium buff-brown, middle and greater underwing coverts dark blackish-brown, this colour linked with the dark outer primaries and appearing as a dark band across the middle of the underwing; a pale wedge on inner primaries; secondaries dark with noticeable barring.

059. Bonelli's Hawk-Eagle, **Hieraetus fasciatus** - V? r. One adult seen over Tughlakabad in December 1985.

060. Imperial Eagle, **Aquila heliaca** - W,o. At least one adult was recorded each year (when observations were made) in the riverain and cultivated areas just north and south of Okhla. In some winters, additional individuals were present some 6-8 km further downstream from Okhla. Sultanpur Lake holds at least one bird each winter; in the 1985-86 winter there were two, an adult and a juvenile. This species appears to actually be more regular now than in the 1960s.

061a. Tawny Eagle, **Aquila rapax vindhiana** - R, o. Not common, and appears to have declined since the 1960s. Not recorded over the city, unlike previously, and only occasionally in cultivation by the river. No breeding records.

061b. Steppe Eagle, **Aquila rapax nipalensis** - W, c. Widespread winter visitor to all areas, including over the city.

062. Greater Spotted Eagle, **Aquila clanga** - W, fc. A minimum of 2-3 birds at Sultanpur Lake each winter. When the reservoir at Okhla is full, Spotted Eagles are often present; 2 well-marked juveniles and one adult were recorded in March 1985. Also occasionally seen in other marshy areas in North Delhi. Hostility is shown towards it by both Steppe and Pallas's Fishing Eagle.

063. Lesser Spotted Eagle, **Aquila pomarina** - V? r. One bird, whose identification can only be as certain as this species permits, was recorded in North Delhi over the marshes beyond Model Town. Only record, January 1986. A smallish head like the Longlegged Buzzard's, noticeably broad rounded wings held forward and drooping from carpal joints when soaring (quite unlike the Steppe/Tawny silhouette) and shortish rounded tail, about two-thirds width of wings. Uniform dark brown body and upper- and under-wing coverts, with darker blackish flight feathers. No white markings at all, above or below. Size, compared with Kite, about 10% larger.

064. Pallas's Fishing Eagle, **Haliaeetus**

leucoryphus - W? r. Has clearly declined. One immature in winter 1978-79, another in December 1985-January 1986, both about the river at Okhla, are the only records. Birds which were recorded in the 1940s and 1950s as breeding by the river in North Delhi and Okhla have evidently abandoned these sites.

065. King Vulture, **Torgos calvus** - V(or R?), r. Very scarce; populations appear to have declined sharply since the 1960s. One pair seen in winter of 1977-78, another in December 1985, both over New Delhi are the only records.

066. Indian Griffon, **Gyps fulvus** - W, s. Single birds, very infrequent, recorded soaring or perched with other vultures in winter.

067. Longbilled Vulture, **Gyps indicus** - R? o. Never over the city, but not uncommon in low hilly and rocky areas as at Sohna, south of Delhi, in winter.

068. Whitebacked Vulture, **Gyps benghalensis** - RB, a.

069. Scavenger Vulture, **Neophron percnopterus** - RB, c.

070. Pale Harrier, **Circus macrourus** - W, s and PM, o. Very small numbers in mid-winter (4 singles in 4 years), more frequent in March when presumably on passage. Numbers may have declined.

071. Montagu's Harrier, **Circus pygargus** - W, r. One male in dry open scrub country near Mehrauli, March 1979, only record.

072. Marsh Harrier, **Circus aeruginosus** - W, c. Arrives early, on 5 August.

073. Short-toed Eagle, **Circaetus gallicus** - R? s. Now rare in immediate vicinity of the city, but still seen occasionally in the riverain tract, Surajkund and Sultanpur.

074. Crested Serpent Eagle, **Spilornis cheela** - PM, s, or V? 3 records of single birds in 4 years; end March and 7 April 1979 and end March 1986; in New Delhi gardens and the Ridge.

075. Osprey, **Pandion haliaeetus** - W, r. Sharply declined, now not usually present in Delhi's vicinity. Only recorded once, at Okhla, winter 1978-79.

076. Laggar Falcon, **Falco jugger** - R? r. Markedly declined and now very scarce. Only 2 records, one bird chased by crows near the Red Fort in December 1984 and one circling over the city on 17 April 1985.

077. Peregrine, **Falco peregrinus** - W, o. A couple of birds every winter on the 8 km stretch of river centered at Okhla, perching on power pylons and hunting over the river and surrounding fields.

078. Redheaded Merlin, **Falco chiquera** - R? r. Declined markedly. Only one record, 8 March 1986, one flying low along the river bank about 3 km south of Okhla.

079. Kestrel, **Falco tinnunculus** - W, fc.

080. Black Partridge, **Francolinus francolinus** - RB, fc.

081. Grey Partridge, **Francolinus pondicerianus** - RB, c.

Both partridges have maintained their numbers where their preferred habitat remains, the Black in cultivation, marshes and scrub, the Grey everywhere in dry country, including rambling New Delhi gardens and the Ridge.

082. Rain Quail, **Coturnix coromandelica** - Breeding M (or R?), o. Frequent locally in wet grassy and marshy areas in both North and South Delhi. Calling at Sultanpur from as early as 4 March through the monsoon. Not noted in winter.

083. Peafowl, **Pavo cristatus** - RB, c. In a semi-feral state, including within city limits.

084. Bustard-Quail, **Turnix suscitator** - RB, o. A male recorded with 3 well grown young on New Delhi Ridge on 25 May 1986.

085. Common Crane, **Grus grus** - W and PM (spring), o. In winter at Sultanpur, dispersing to feed over the surrounding fields. Estimated minimum of 300 on 1 March 1986. Small parties of 3 or 4 noted occasionally elsewhere, as at Okhla. In end March, flocks of about 150 noted on 3 separate occasions flying northwards, high over the river at Okhla in 1979 and 1985.

086. Sarus Crane, **Grus antigone** - RB, o. Scattered, in small numbers, in surrounding countryside. No large gatherings noted. Parties of parents with flying young occur, so presumably resident in the area.

087. Demoiselle Crane, **Anthropoides virgo** - PM? s. 11 birds at Sultanpur Lake on 1 March 1986.

088. Spotted Crake, **Porzana porzana** - V (or W, r?). New record for Delhi. One bird, studied closely from 6 m distance through binoculars, feeding along the edge of a reedy pond at Sultanpur at 8 a.m. on 4 March 1979.

089. Baillon's Crake, **Porzana pusilla** - PM? o. Small numbers, usually under 10 on a given day, occasionally seen about hyacinth covered channels at Okhla, in March.

090. Ruddy Crake, **Porzana fusca** - R, s. Small numbers seen in winter 1985-86 feeding in waterlogged openings in reedbeds at Madanpur, about 6 km south of Okhla. This is the same place where they were first recorded for Delhi by J. Donahue in June-July 1962. Not only has this species maintained itself in Delhi, the birds are probably residents.

091. Brown Crake, **Amaurornis akool** - R, o. Noted both summer and winter in marshes in North Delhi, about Okhla and Madanpur, occasionally elsewhere, even on the edge of small ponds in dry scrub country such as the campus of Jawaharlal Nehru University. Singles and pairs. May have increased in both numbers and range since the 1960s.

092. Whitebreasted Waterhen, **Amaurornis phoenicurus** - RB, c.

093. Watercock, **Gallicrex cinerea** - M (breeding)? s. In July 1979, at least 4 males in breeding plumage were seen feeding in the open and 'singing' in the evening at marshes in North Delhi near the Coronation Pillar. Further investigation will probably prove it to be a regular breeder in these marshes (if the habitat does not deteriorate) as well as around Okhla and Madanpur.

094. Moorhen, **Gallinula chloropus** - RB, c. Downy chicks noted on 22 March 1986.

095. Purple Gallinule, **Porphyrio porphyrio** - RB, c.

096. Coot, **Fulica atra** - W, a, and R, s. Large numbers in winter. Very few birds are also seen through the summer, especially in North Delhi, but no evidence of breeding.

097. Pheasant-tailed Jacana, **Hydrophasianus chirurgus** - M (breeding), fc, and R, s. Fairly common second half of March to September, presumably breeding. Very small numbers in winter.

098. Bronze-winged Jacana, **Metopidius indicus** - V? or R? s. There are very few earlier records of the species from Delhi. Not recorded 1978-79. In 1985-86, single birds or pairs were present in February and May at Okhla; a pair was again present in the same area on a later visit, 5 August 1989. Perhaps establishing itself as a resident.

Most of Delhi's waders have maintained their populations; some species, previously considered rare stragglers during spring migration have, in recent years, occurred with increasing regularity, such as the Curlew Sandpiper and the Lesser Sand Plover.

099. Whitetailed Lapwing, **Vanellus leucurus** - W, fc.

100. Green Lapwing, **Vanellus vanellus** - W, o. Small parties of usually under 20, once about 40, between December and March.

101. Spurwinged Lapwing, **Vanellus duvauceli** - RB, c. Common about Jamuna sandbanks. Judging from behaviour, several scattered pairs had either eggs or young in the same general area in Okhla in May 1986.

102. Red-wattled Lapwing, **Vanellus indicus** - RB, c.

103. Yellow-wattled Lapwing, **Vanellus malabaricus** - R, fc. Small numbers in dry country near Tughlakabad, Mehrauli and Surajkund.

104. Grey Plover, **Pluvialis squatarola** - V, on spring passage. 2 in partial breeding plumage on Okhla sandbank on 6 May 1979.

105. Little Ringed Plover, **Charadrius dubius** - RB, c. Breeding in May; by end-May, small parties form, of 10-15 adults and juveniles.

106. Kentish Plover, **Charadrius alexandrinus** - W, c. From March, several in breeding plumage, and increased numbers indicating passage. A pair in breeding plumage was present at Okhla in mid-June, but no evidence was noted of breeding.

107. Caspian Plover, **Charadrius asiaticus** - V, in spring. New record for Delhi. One bird, in breeding plumage was present on closely cropped grazing land near Sultanpur Lake on 1 March 1986, loosely associated with a pair of Indian Coursers. Studied through binoculars from about 28 m distance.

Size about two-thirds that of a Courser. Rather pale brown crown, back and wings, and a clearcut brown band from eye curving back and down to meet brown hindneck. Forehead, long broad eyebrow, lores, throat and cheeks pure white. Broad rufous-chestnut band across breast bordered below with a thin black line. Belly and vent white, conspicuous when bird dipped. In flight wings appeared long and narrow (like a Golden Plover in the distance); faint wingbar, underside of wings whitish. Tail short. Eye dark and conspicuous, bill dark, legs brownish.

108. Lesser Sand Plover, **Charadrius mongolus** - PM (spring), o. Throughout the second half of May, both in 1985 and 1986, a maximum of 20 birds were present daily on sandbanks at Okhla below the weir; in 1986, one was present as early as 9 May. Most were in full breeding plumage.

109. Curlew, **Numenius arquata** - W, o. Singly or in parties of up to 20, preferring marshes to the river.

110. Blacktailed Godwit, **Limosa limosa** - W, fc. Wintering numbers vary year to year. At Sultanpur, abundant 1978-79, few (under 100) 1985-86.

111. Dusky Redshank, **Tringa erythropus** - W, o, and PM in spring. Marked spring passage, e.g. about 150, most in breeding plumage, at Sultanpur on 5 May 1985.

112. Redshank, **Tringa totanus** - W, fc.

113. Greenshank, **Tringa nebularia** - W, c.

114. Marsh Sandpiper, **Tringa stagnatilis** - W, o and PM. Sometimes common on autumn passage, many still in breeding plumage, in late-July and August, and in spring in April.

115. Wood Sandpiper, **Tringa glareola** - W, c.

116. Green Sandpiper, **Tringa ochropus** - W, c.

117. Terek Sandpiper, **Xenus cinereus** - V, on spring passage. One, in breeding plumage, on Okhla sandbank with numerous other waders on 9 May 1979. Has been recorded once earlier at about the same date at the same place (Usha Ganguli) in 1968.

118. Common Sandpiper, **Actitis hypoleucos** - W, c.

119. Common Snipe, **Gallinago gallinago** - W, c. At times very numerous in North Delhi marshes, with numbers that must run into a few hundreds scattered over inundated grassy marshes, e.g. in December 1985.

120. Little Stint, **Calidris minutus** - W, fc, and PM, a, in spring. Numbers at Okhla in April-mid May can be spectacular, running into several hundreds if not thousands, with smaller groups present till early June.

121. Temminck's Stint, **Calidris temminckii** - W, c. Often commoner than Little Stint in mid-winter; numbers increase in spring.

122. Dunlin, **Calidris alpinus** - W, o. Small numbers regular at Sultanpur, irregular by the river. Occasionally seen in breeding plumage at Okhla in the first week of May.

123. Curlew Sandpiper, **Calidris testaceus** - PM (spring), o. Not infrequent on spring passage at Okhla, up to 30 birds present on sandbanks below the weir, between 5 May and 9 June, many in breeding plumage. One autumn record of about 10 at Okhla on 21 October 1985.

124. Ruff, **Philomachus pugnax** - W, fc. In 1986, 2 males were present at Okhla as late as 9 June; one in nearly complete breeding plumage with black ruff and ear-tufts, reddish around eye and a reddish-orange bill.

125. Painted Snipe, **Rostratula benghalensis** - RB, fc. More often noticed May to July, feeding in the open, chasing each other, flying about and calling.

126. Blackwinged Stilt, **Himantopus himantopus** - W, c. Small numbers seen in summer but no evidence of breeding.

127. Avocet, **Recurvirostra avosetta** - R, fc. Present both in winter and dry season, by the river,

lakes and marshes. Maximum of 300 on the Jamuna river in winter 1978-79, but such numbers were not seen in 1985-86. It appears to have become commoner since the 1960s.

128. Stone Curlew, **Burhinus oedicnemus** - RB, fc.

129. Great Stone Plover, **Esacus magnirostris** - R? s. Records of singles or pairs on river sandbanks, in late winter and summer. The flocks of "20 to more than 50" recorded by Usha Ganguli in the 1960s are gone. This species has clearly declined in the area.

130. Indian Courser, **Cursorius coromandelicus** - RB? s. Very local. Curious display by a pair seen in March 1986; on alarm, pair flew off, then suddenly changed style of flight to deep jerky wingbeats, like a displaying Shikra or a pigeon in 'delayed wingbeat mode'; both birds then swooped upwards and towards each other with partly closed wings, then down again; this sequence repeated thrice.

131. Oriental Pratincole, **Pratincola maldivarum** - M, fc. Present around river from May, then in increased numbers from June to August-September, when flocks of 50-75 occur, wheeling and calling at dusk. No evidence of breeding.

132. Little Pratincole, **Pratincola glareola** - R (RB?), c. Present all year, but most visible from February to June, when swarms of several hundred may occur at dusk at Sultanpur and on the river. In late May-early June 1986, several birds scattered over sandflats at Okhla performed 'broken-wing trick' on approach, but no nests could be found.

133. Herring Gull, **Larus argentatus** - W, o. Small numbers, maximum of 15, at Sultanpur Lake and the river. There may be two races, since some birds have the back distinctly darker grey than others.

134. Great Blackheaded Gull, **Larus ichthyaetus** - W, o. Most often noted in spring, both on the river and Sultanpur Lake.

135. Brownheaded Gull, **Larus brunnicephalus** - W, fc. Flocks of up to 100 in March-April, indicative of passage.

136. Blackheaded Gull, **Larus ridibundus** - W, c. Often in larger numbers than Brownheaded; both species appear to have increased since the 1960s, and become more regular.

137. Whiskered Tern, **Chlidonias hybrida** - R, fc, and PM (spring), a. Present all year in fair numbers, e.g. up to 200 around Okhla and 100 at Sultanpur in December 1985. Massive spring passage evident from early March to mid-May, when most birds in breeding plumage. By mid-April, the river swarms with these terns with about 3000 birds in a 3 km stretch upstream in Okhla. After mid-May, numbers reduce sharply, with most birds thereafter on the river not in breeding dress. Several birds at marshes in North Delhi in July 1979 may indicate breeding, but no confirmation.

138. Whitewinged Black Tern, **Chlidonias leucoptera** - V. On spring passage. One in breeding plumage with Whiskered Terns at Okhla on 9 June 1986.

139. Gullbilled Tern, **Gelochelidon nilotica** - W, fc. Small numbers in winter; commoner March-June when flocks of 25-30 occur, usually in breeding plumage. There appears to have been some reduction in numbers since the 1960s.

140. River Tern, **Sterna aurantia** - RB, c. Just fledged juveniles in early June at Okhla. By early August, 50% of the River Terns present at Okhla appear to be juveniles of the year.

141. Blackbellied Tern, **Sterna acuticauda** - RB, c. Rather less common than River Tern.

142. Little Tern, **Sterna albifrons** - M (breeding?), o. Small numbers by the river in summer and monsoon. By July-August several juveniles are seen, and then the birds also wander to flooded marshes away from the river. Maximum of 25 at Okhla in August 1989. May have declined since the 1960s.

143. Indian Skimmer, **Rynchops albicollis** - PM? or V? r. This species has declined sharply. Compared to earlier records of breeding on the Jamuna sandbanks, and presence in some numbers during the summer, the bird was noted only twice over 4 years - a pair each in September 1978 and on 25 May 1985, on the river.

144. Indian Sandgrouse, **Pterocles exustus** -

RB, fc. Stony scrub in South Delhi and around Sultanpur Lake.

145. Painted Sandgrouse, **Pterocles indicus** - R (RB?), o. Small numbers throughout the year in scrubby and rocky areas near Mehrauli and the Jawaharlal Nehru University campus.

146. Common Green Pigeon, **Treron phoenicoptera** - RB, fc. More noticeable from February to May, the breeding season.

147. Blue Rock Pigeon, **Columba livia** - RB, a. Feral.

148. Ring Dove, **Streptopelia decaocto** - RB, a.

149. Red Turtle Dove, **Streptopelia tranquebarica** - RB, fc. Breeding freely in the green areas of the city March to May, thereafter spreading out in flocks of up to 50 in the surrounding countryside.

150. Spotted Dove, **Streptopelia chinensis** - V. 4 records of singles, January, February and April, in 4 years.

151. Little Brown Dove, **Streptopelia senegalensis** - RB, a.

152. Large Indian Parakeet, **Psittacula eupatria** - RB, fc. Has increased since the 1960s.

153. Roseringed Parakeet, **Psittacula krameri** - RB, a.

154. Blossomheaded Parakeet, **Psittacula cyanocephala** - RB, fc.

155. Pied Crested Cuckoo, **Clamator jacobinus** - M (breeding), fc. Recorded between June 1 and October 24.

156. Common Hawk-Cuckoo, **Cuculus varius** - RB, fc. Well distributed from early March onwards, but rarely noted in winter.

157. Common Cuckoo, **Cuculus canorus** - V. Straggler during spring passage. One record, 5 April 1979.

158. Drongo-Cuckoo, **Surniculus lugubris** - V. New record for Delhi. One was seen on 10 May 1986, perched on a kikar tree on the New Delhi Ridge in the evening, a day after a violent storm. Its presence attracted two noisy Black Drongos to the tree; disturbed, it flew off, followed by the Drongos. The Cuckoo's different style of flight, a continuous lazy flapping, its shallow incomplete tailfork with some whitish on vent and different shape of beak were clues to identification.

159. Koel, **Eudynamys scolopacea** - RB, c.

160. Sirkeer Cuckoo, **Taccocua leschenaultii** - RB, o. Widely distributed though uncommon, on the Ridge, Mehrauli, Surajkund and Sultanpur.

161. Greater Coucal, **Centropus sinensis** - RB, c. Often in reedbeds.

162. Barn Owl, **Tyto alba** - RB, s. Most easily seen about the Red Fort at dusk.

163. Eagle-Owl, **Bubo bubo** - RB, o. Often around ruins and rocky areas of Mehrauli. Distraction displays in January near nest.

164. Spotted Owlet, **Athene brama** - RB, c.

165. Shorteared Owl, **Asio flammeus** - PM (spring), r. Two records, both near Okhla, on 17 March 1979 and 8 March 1986.

166. Indian Nightjar, **Caprimulgus asiaticus** - RB? o. Appears to have declined. Heard calling in open stony country in South Delhi. No records of gatherings of up to a dozen birds in September-October (indicative of migration?) as recorded previously.

167. Franklin's Nightjar, **Caprimulgus affinis** - RB? (or M,breeding?), o. A few birds recorded in March-April 1979 calling in flight over rocky ravines in the Jawaharlal Nehru University campus. Previously recorded in various months between May and September, in the Delhi area.

168. House Swift, **Apus affinis** - RB, c.

169. Palm Swift, **Cypsiurus parvus** - V. Singles noted at Okhla and over New Delhi on 17 March and 14 July 1979 respectively.

170. Pied Kingfisher, **Ceryle rudis** - RB, c.

171. Common Kingfisher, **Alcedo atthis** - RB (and W?), c.

172. Whitebreasted Kingfisher, **Halcyon smyrnensis** - RB, c.

173. Bluecheeked Bee-eater, **Merops superciliosus** - M (breeding), fc. Earliest record 24 May. Late-July to September, very large gatherings sometimes occur on overhead wires, etc. especially near marshes and the river, probably preparatory to migration.

174. Little Green Bee-eater, **Merops orientalis** - RB, c. Numbers increase in spring, when parties of up to 20 birds may be seen in March flying northwest in the mornings.

175. Indian Roller, **Coracias benghalensis** - RB, fc. A few birds appear to enter city limits in summer from surrounding areas to breed in city parks, etc.

176. Hoopoe, **Upupa epops** - RB, c.

177. Grey Hornbill, **Tockus birostris** - RB, fc. Flying young in late-March and April.

178. Green Barbet, **Megalaima zeylanica** - RB, c.

179. Coppersmith Barbet, **Megalaima haemacephala** - RB, c.

180. Wryneck, **Jynx torquilla** - W, o. Numbers increase in first half of March, evidence of passage.

181. Goldenbacked Woodpecker, **Dinopium benghalense** - RB, fc.

182. Yellowfronted Pied Woodpecker, **Picoides mahrattensis** - RB, o. In thorn scrub.

183. Redwinged Bushlark, **Mirafra erythroptera** - RB, c.

184. Ashycrowned Finchlark, **Eremopterix grisea** - RB, c.

185. Rufoustailed Finchlark, **Ammomanes phoenicurus** - RB? r. In very small numbers in rocky terrain at Tughlakabad, and further south near Sohna and Nuh (in cultivated country).

186. Short-toed Lark, **Calandrella cinerea** - W, c. Most frequent in neighbourhood of marshes as at Sultanpur.

187. Sand Lark, **Calandrella raytal** - RB, c. About the river.

188. Eastern Calandra Lark, **Melanocorypha bimaculata** - IW, r. About 20 seen with Short-toed Larks and Spanish Sparrows in open ground near the marshes near the Coronation Pillar in North Delhi on 10 February 1978; one seen with Short-toed Larks near Mehrauli on 4 January 1986.

189. Crested Lark, **Galerida cristata** - RB, c.

190. Little Skylark, **Alauda gulgula** - RB, fc.

191. Indian Sand Martin, **Riparia paludicola** - RB, c.

192. Dusky Crag Martin, **Hirundo concolor** - RB, fc.

193. Common Swallow, **Hirundo rustica** - W, c.

194. Wiretailed Swallow, **Hirundo smithii** - RB, c.

195. Cliff Swallow, **Hirundo fluvicola** - RB, fc.

196. Redrumped Swallow, **Hirundo daurica** - RB, fc.

197. Great Grey Shrike, **Lanius excubitor** - RB, c. In the surrounding countryside, cultivation and scrub.

198. Baybacked Shrike, **Lanius vittatus** - RB, c. In babool and prosopis groves, even in city parks.

199. Isabelline Shrike, **Lanius isabellinus** - W. fc. Noted in the uncultivated dessicating flats surrounding drying-up marshes in north and south Delhi and around the Sultanpur lakes, and fallow fields adjacent to the river. Not in cultivation or dry scrub country.

200. Rufousbacked Shrike, **Lanius schach** - RB, fc. In wooded areas and near water. Least numerous of the three resident shrikes.

201. Brown Shrike, **Lanius cristatus** - V. Delhi lies at the western edge of the usual wintering range of this species. One bird was present between 15 and 25 December 1985 at Okhla.

202. Golden Oriole, **Oriolus oriolus** - M (breeding), c. In city gardens and the larger groves in the countryside. Arrives by end-March.

203. Black Drongo, **Dicrurus macrocercus** - RB, c. In winter, most birds seem to leave the city for the surrounding countryside, returning to breed in city parks, etc. in March. Some migration is also evident; by end-March, when many pairs have established territory and are building, others, singly or in parties of up to 7, are seen flying northwest over Delhi at about 30 m height.

204. Grey Drongo, **Dicrurus leucophaeus** - V or PM (spring), r. One record; a bird on 31 March 1985 in a New Delhi garden.

205. Whitebellied Drongo, **Dicrurus merulinus** - V. Two records; singles on 26 October 1978 and 19 January 1986, both times in *Prosopis*

woodland in New Delhi zoo.

206. Greyheaded Myna, **Sturnus malabaricus** - V or PM (spring), r. Two records; singles on the same date, 7 March, in both 1979 and 1985 at Okhla and in a city garden respectively.

207. Brahminy Myna, **Sturnus pagodarum** - RB, c.

208. Rosy Pastor, **Sturnus roseus** - PM, s and W, r. In contrast to the large scale passage noted by Hutson and Ganguli in the 1940s-1960s, this species is now remarkably scarce. In autumn, small parties of about 10, mostly juveniles, are seen rarely; in spring, only a few small groups of 3 to 6 between 30 March and 20 April. Once in mid-winter, about 15 in a roost with Common Mynas in January 1978.

209. Starling, **Sturnus vulgaris** - W, fc. Locally common.

210. Pied Myna, **Sturnus contra** - RB, c.

211. Common Myna, **Acridotheres tristis** - RB, a.

212. Bank Myna, **Acridotheres ginginianus** - RB, c. Breeding freely in flood control bunds and dykes. Enormous roosts of 1000s in green areas of the city, such as the Central Vista in March and April.

213. Indian Treepie, **Dendrocitta vagabunda** - RB, c.

214. House Crow, **Corvus splendens** - RB, a.

215. Jungle Crow, **Corvus macrorhynchos** - RB?, s. Small numbers are present all year, in contrast to the 1960s, when it seems to have been far rarer.

216. Common Wood-Shrike, **Tephrodornis pondicerianus** - RB, c.

217. Large Cuckoo-Shrike, **Coracina novaehollandiae** - V. One record, one bird on 5 April 1979 on the Ridge, hotly chased by a Crow.

218. Longtailed Minivet, **Pericrocotus ethologus** - W, o.

219. Little Minivet, **Pericrocotus cinnamomeus** - RB, fc.

220. Marshall's Iora, **Aegithinia nigrolutea** - R, r. In the 1960s and earlier, this species was recorded as a resident in small numbers from several localities in the Delhi area. It is now extremely scarce. Noted only on the New Delhi Ridge, where it was seen occasionally in 1978-79, but only once in the years 1985-86, on 1 June 1986.

221. Redwhiskered Bulbul, **Pycnonotus jocosus** - RB, c.

222. Whitecheeked Bulbul, **Pycnonotus leucogenys** - RB, fc.

223. Redvented Bulbul, **Pycnonotus cafer** - RB, a.

224. Yelloweyed Babbler, **Chrysomma sinense** - RB, fc.

225. Common Babbler, **Turdoides caudatus** - RB, c.

226. Striated Babbler, **Turdoides earlei** - RB, fc. In marshes and reedbeds; also noted in *Prosopis* scrub covering the sides of flood control embankments by the river.

227. Large Grey Babbler, **Turdoides malcolmi** - RB, fc.

228. Jungle Babbler, **Turdoides striatus** - RB, c.

229. Redbreasted Flycatcher, **Muscicapa parva** - W, fc. Few in mid-winter, but marked passage from mid-March to mid-April.

230. Verditer Flycatcher, **Muscicapa thalassina** - PM, r. A pair on 9 March 1986 at Surajkund, the only record.

231. Greyheaded Flycatcher, **Culicicapa ceylonensis** - W, o. Not uncommon in singles or twos and threes in better wooded corners.

232. Whitebrowed Fantail-Flycatcher, **Rhipidura aureola** - R, s. Appears to have sharply declined in numbers since the 1960s.

Previously considered a not uncommon resident. Now only very occasionally seen in babool woodland, usually singly, and appears shy and vagrant. Exceptional in city gardens or in *Prosopis* woodland on the Ridge. Its decline may well be linked to the rapid loss of former indigenous habitats around Delhi.

233. Fantail-Warbler, **Cisticola juncidis** - RB, c.

234. Franklin's Wren-Warbler, **Prinia hodgsonii** - RB, c. In taller scrubland, parks, woodland on the Ridge.

235. Rufousfronted Wren-Warbler, **Prinia buchanani** - RB, c. In low, dry thorn scrub.

236. Streaked Wren-Warbler, **Prinia gracilis** - RB, fc. In grass and tamarisk trees near the river, reedbeds in marshes.

237. Plain Wren-Warbler, **Prinia subflava** - RB, c. In cultivation, grass and bush areas, reedbeds.

238. Ashy Wren-Warbler, **Prinia socialis** - RB, c. In gardens, parks, taller cultivation such as sugarcane, etc.

239. Yellowbellied Wren-Warbler, **Prinia flaviventris** - RB, c. New species on the Delhi list. First recorded in March 1979 in the reedbeds by the river just above the weir at Okhla, and again in 1985-86 at the same place as well as in the extensive reedbeds at Madanpur, a few kilometres further south. In both localities it is common, and co-exists with the equally abundant Streaked, and the less common Plain Wren-Warbler. Evidently resident, seen in pairs and singing freely in March; mating observed in July. The presence of this species in Delhi, especially as a breeder, represents a considerable range extension.

240. Tailor Bird, **Orthotomus sutorius** - RB, c.

241. Striated Marsh Warbler, **Megalurus palustris** - R, fc. Another new species on the Delhi list. First recorded in November 1978 at the marshes near the Coronation Pillar in North Delhi, and found later through 1979 and in 1985-86 at the same place and at Madanpur south of Okhla. Recorded throughout the year, and song and display flights noted, so presumably breeds. The Delhi area is well within the range of the species, so its presence here is not unexpected.

242. Indian Great Reed Warbler, **Acrocephalus stentoreus** - M (breeding?) or RB? fc. Often common at suitable localities between March and August. Many noted singing in May and July at Madanpur in South Delhi.

243. Blyth's Reed Warbler, **Acrocephalus dumetorum** - PM, fc. More noticeable in spring, early-April to mid-May.

244. Paddyfield Warbler, **Acrocephalus agricola** - PM (spring), s. Small numbers, last week of March through April.

245. Booted Warbler, **Hippolais caligata** - PM (spring), s. Irregularly and in small numbers, from the last week of March to the second week of May, in gardens and reedbeds. Unlike previously, not recorded in autumn.

246. Orphean Warbler, **Sylvia hortensis** - W, r. Only two records, January 1978 and December 1985.

247. Lesser Whitethroat, **Sylvia curruca** - W, c.

248. Chiffchaff, **Phylloscopus collybita** - W, c.

249. Olivaceous Leaf-Warbler, **Phylloscopus griseolus** - W, o and PM, fc. Formerly considered only a passage migrant. Small numbers were present all winter in 1977-79 and 1985-86 in suitable habitat on the Ridge, at Surajkund and at Tughlakabad, with marked spring passage in March.

250. Yellowbrowed Leaf-Warbler, **Phylloscopus inornatus** - W, c.

251. Brook's Leaf-Warbler, **Phylloscopus subviridis** - PM (spring), s. Small numbers presumed on passage in the second half of March in *Prosopis* woodland on the New Delhi Ridge; birds are then singing freely, which assists in their identification from the common Yellowbrowed (Hume's) Leaf-Warblers. May also be present in winter.

252. Greenish Leaf-Warbler, **Phylloscopus trochiloides** - PM, o. Previously recorded as occurring only, though fairly commonly, on autumn passage, with very few in winter. Records during 1977-79 and 1985-86 are only of small numbers, but on both passages, September-early October in autumn, and mid-March to mid-April in spring, when singing freely.

253. Green Leaf-Warbler, **Phylloscopus nitidus** - V or PM (spring), r. One record of a well marked bird on 20 April 1979, on the New Delhi Ridge.

254. Large Crowned Leaf-Warbler, **Phylloscopus occipitalis** - PM, r. Two records, one on 20 September 1979 and two on 23 March 1986, on the New Delhi Ridge.

255. Common Rubythroat, **Erithacus calliope** - V or PM, r. Two records, a male on the Ridge on 31 October 1978 and another at Okhla on 24 March 1979.

256. Bluethroat, **Erithacus svecicus** - W, fc.

257. Magpie-Robin, **Copsychus saularis** - RB, o.

258. Black Redstart, **Phoenicurus ochruros** - W, fc.

259. Brown Rockchat, **Cercomela fusca** - RB, fc.

260. Collared Bushchat, **Saxicola torquata** - W, c. In surrounding cultivation.

261. Whitetailed Bushchat, **Saxicola leucura** - RB, fc. New species on the Delhi list. First noted in December 1978 at the marshes near the Coronation Pillar in North Delhi. Subsequently found to be common in 1979 and in 1985-86 in reedbeds and wet cultivation about Okhla and Madanpur in South Delhi, where it is resident and present all seasons. Males noted singing as early as late-January; song flights recorded in March, the males flying up 5 m then fluttering down with open tail, singing all the while. By last week of March, some pairs are building, a few already feeding just-fledged young.

262. Pied Bushchat, **Saxicola caprata** - RB, fc. Usually near water, river, canal banks, lakes or marshes.

263. Desert Wheatear, **Oenanthe deserti** - W, o. More frequent in March, by the river and in open country near Surajkund.

264. Indian Robin, **Saxicoloides fulicata** - RB, c.

265. Blue Rockthrush, **Monticola solitarius** - W, o.

266. Blackthroated Thrush, **Turdus ruficollis** - W, o. Present most winters, usually in small numbers.

267. Grey Tit, **Parus major** - V. One on 4 January 1986 with a mixed party of warblers, minivets and a Yellowfronted Pied Woodpecker in a South Delhi 'city forest'.

268. Firecapped Tit, **Cephalopyrus flammiceps** - PM (spring), r. A party of 5 in a shisham grove in a New Delhi nursery on 29 March 1986.

269. Chestnutbellied Nuthatch, **Sitta castanea** - R, r or V. This species was scarce even in the past and seems to have declined further. A group of three in a New Delhi garden in December 1978 and a single at Okhla in March 1979 are the only records.

270. Indian Tree Pipit, **Anthus hodgsoni** - W, fc.

271. Tree Pipit, **Anthus trivialis** - PM (spring), s. Considered by Usha Ganguli as a winter visitor, 'not too common' but more frequent than the Indian Tree Pipit. It now appears to be only a scarce passage migrant; very few records in the last week of March. Usually in heavier grassy cover than the Indian Tree Pipit.

272. Indian Pipit, **Anthus novaeseelandiae** - RB, c.

273. Tawny Pipit, **Anthus campestris** - W, o. In low open scrub and grazing areas about Tughlakabad and Mehrauli.

274. Vinaceousbreasted Pipit, **Anthus roseatus** - W, o. Frequent in some winters, scarce in others, in marshes and about canal banks and bunds near the river; entering into breeding plumage in March.

275. Brown Rock Pipit, **Anthus similis** - W and PM, s. Most often noted in spring, also in mid-winter. In low rocky scrub on the Ridge and elsewhere and on flood protection embankments by the river.

276. Yellow Wagtail, **Motacilla flava** - W, c. Abundant on spring passage.

277. Yellowheaded Wagtail, **Motacilla citreola** - W, c. *M. c. calcarata* is a spring passage migrant, noted between 15 March and 24 May.

278. Grey Wagtail, **Motacilla caspica** - W, s.

279. White Wagtail, **Motacilla alba** - W, c. Both *personata* and *dukhunensis* occur commonly, the latter rather more so. One *alboides* recorded in full breeding plumage at Surajkund on 9 March 1986.

280. Large Pied Wagtail, **Motacilla maderaspatensis** - RB, c.

281. Purple Sunbird, **Nectarinia asiatica** - RB, c.

282. White-eye, **Zosterops palpebrosa** - RB, c.

283. House Sparrow, **Passer domesticus** - RB, a.

284. Spanish Sparrow, **Passer hispaniolensis** - IW, s. About 30 with Short-toed Larks and Eastern Calandra Larks at marshes in North Delhi on 10 February 1978; about 20 with Short-toed Larks, Starlings, Red Turtle Doves and House Sparrows at Sultanpur on 28 December 1985, are the only records.

285. Yellowthroated Sparrow, **Petronia xanthocollis** - RB, fc. There seems to be a breeding influx into wooded areas of the city in summer.

286. Baya Weaver, **Ploceus philippinus** - RB, c.

287. Blackthroated Weaver, **Ploceus benghalensis** - RB, c. Appears to have increased since the 1960s when it was recorded as very uncommon. Large flocks are now seen in reedbeds and marshes, and by the river, and it breeds freely in these areas in the monsoon.

288. Striated Weaver, **Ploceus manyar** - RB, fc. In contrast to the position recorded in the 1960s, this species now appears less common than the preceding one. It also occupies a different ecological niche, preferring smaller channels and ponds with overhanging grass and vegetation; the Blackthroated prefers reedbeds or areas of tall grass standing on wet ground.

289. Red Munia, **Amandava amandava** - RB, fc. Appears to have increased around marshes and wet cultivation. In the non-breeding season, small parties also occur in dry short grass and scrub areas such as the Ridge and Mehrauli.

290. Whitethroated Munia, **Lonchura malabarica** - RB, c.

291. Spotted Munia, **Lonchura punctulata** - RB, s. Occasionally seen at Okhla. A family party of 2 adults and 3 juveniles once seen on the Ridge.

292. Blackheaded Munia, **Lonchura malacca** - RB? Escapes? About 20 at Madanpur on 6 July 1986. Previously recorded by P. Jackson breeding at this locality in September.

293. Common Rosefinch, **Carpodacus erythrinus** - W, o. Sometimes common on the Ridge, particularly on passage in April.

294. Redheaded Bunting, **Emberiza brunniceps** - V or PM, r. Formerly (1960s) considered a fairly common spring migrant, it now seems very scarce; 3 on 4 February 1979 is the only record over five seasons.

295. Whitecapped Bunting, **Emberiza stewarti** - W, o and PM, fc. Small numbers present in suitable thorn scrub areas such as the Ridge all winter. Commoner and more widespread on passage from early-March to mid-April.

296. Greynecked Bunting, **Emberiza buchanani** - PM, r. One on 28 March 1979 in dry open scrub near Mehrauli, only record.

DISCUSSION

A comparison of the above with previous literature would appear to indicate a definite change in the populations of several species. 6 species were recorded for the first time in the Delhi area; 20 species appear to show an increase in their populations; and 27 species appear to have decreased. These are listed in Table A.

The total number of species recorded in the Delhi area so far is about 410. 296 were recorded during the above periods of observation. Of the remaining 114 species:

— 16 fall in the category of former/presumed breeders.

— 11 have been characterised in past literature as rare but probably regular winter-visitors or passage migrants.

— 17 have been characterised in past literature as irregular winter-visitors or passage migrants.

— 69 fall in the category of vagrants or inadvertent stragglers; these are not considered further in this paper.

The first three categories are listed in Table B.

A perusal of the two tables would indicate:

1. 13 species of birds of prey are noted as decreasing, and 2 raptor species, formerly recorded

TABLE A

	New Record		Increasing		Decreasing
1.	Spotted Crake	1.	Large Cormorant	1.	Blacknecked Stork
2.	Caspian Plover	2.	Indian Shag	2.	Adjutant Stork
3.	Drongo-Cuckoo	3.	Purple Heron	3.	White Ibis
4.	Yellow-bellied Wren-Warbler	4.	Chestnut Bittern	4.	Crested Honey Buzzard
5.	Striated Marsh Warbler	5.	Openbill Stork	5.	Brahminy Kite
6.	White-tailed Bush-Chat	6.	Barheaded Goose	6.	White-eyed Buzzard
		7.	Lesser Whistling Teal	7.	Bonelli's Eagle
		8.	Spotbill	8.	Tawny Eagle
		9.	Longlegged Buzzard	9.	Lesser Spotted Eagle
		10.	Imperial Eagle	10.	Pallas' s Fishing Eagle
		11.	Greater Spotted Eagle	11.	King Vulture
		12.	Brown Crake	12.	Pale Harrier
		13.	Bronzewinged Jacana	13.	Short-toed Eagle
		14.	Avocet	14.	Osprey
		15.	Brownheaded Gull	15.	Laggar Falcon
		16.	Blackheaded Gull	16.	Redheaded Merlin
		17.	Jungle Crow	17.	Great Stone Plover
		18.	Olivaceus Leaf-Warbler	18.	Little Tern
		19.	Blackthroated Weaver	19.	Indian Skimmer
		20.	Red Munia	20.	Indian Nightjar
				21.	Rosy Pastor
				22.	Marshall's Iora
				23.	White-browed Fantail Flycatcher
				24.	Chestnutbellied Nuthatch
				25.	Tree Pipit
				26.	Striated Weaver
				27.	Redheaded Bunting

as irregular visitors were not re-recorded. Significantly, 11 of the 13 decreasing species and one of the formerly irregular visitors are resident species. In contrast, most migrant raptors (winter visitors) have maintained their numbers, and three (Long-legged Buzzard, Imperial Eagle and Greater Spotted Eagle) actually appear to be commoner and more regular than previously recorded.

This is an ominous sign. Even relatively common raptors, such as Tawny Eagle, White-eyed Buzzard and Crested Honey Buzzard, have noticeably declined. If migrant raptors can maintain their numbers, it would appear that shortage of food or loss of habitat is not a major constraint (at least for most species); this points to disturbance in their breeding cycles as the likely cause of the decrease of resident species in the Delhi area. This is as likely to be direct - physical disturbance, noise pollution, loss of traditional nesting sites - as indirect, effect of pesticides and other poisons, for example - or, likely, both. In the case of the two falcons (Laggar and Red-headed), which have adapted well to urban areas elsewhere, the latter is probably the likely cause. Much more detailed study would be required to establish the causes precisely.

2. Similar factors as for raptors are probably involved for the 3 owls, particularly the Dusky Eagle-owl, which were formerly categorised as not uncommon breeders, but were not re-recorded at all in the present study.

Table B

Formerly Presumed or Confirmed Breeder	Formerly Considered Regular but Rare in Winter or Passage	Formerly Considered Irregular Winterer or Passage Migrant
1. Little Bittern	1. Hen Harrier	1. Spotted-billed Pelican
2. Black Bittern	2. Common Quail	2. White Stork
3. Lesser Spotted Eagle	3. Sociable Plover	3. Glossy Ibis
4. Jungle Bush-Quail	4. Pintail Snipe	4. Greyheaded Fishing Eagle
5. Button-Quail	5. Jack Snipe	5. Cinerous Vulture
6. Yellowlegged Button-Quail	6. Imperial Sand-grouse	6. Common Tern
7. Blue-breasted Banded Rail	7. Rufous Turtle-Dove	7. Sykes' Nightjar
8. Great Indian Bustard	8. White-bellied Minivet	8. Kashmir Roller
9. Collared Scops-Owl	9. Isabelline Wheatear	9. Skylark
10. Dusky Eagle-Owl	10. Pied Wheatear	10. Collared Sand-Martin
11. Brown Fish-Owl	11. Water Pipit	11. White-browed Blue Flycatcher
12. Bluetailed Bee-eater		12. Moustached
13. Paradise Flycatcher		13. Plain Leaf-Warbler
14. Jungle Wren-Warbler		14. Tickell's Leaf-Warbler
15. Bristled Grass-Warbler		15. Orange-headed Ground-Thrush
16. Spotted Grey Creeper		16. Wall Creeper
		17. Crested Bunting

3. Water and marsh haunting species present a mixed picture. Some are doing relatively better than may be expected. Expansion of seepage marshes and waterlogging may be an explanation. 14 such species (2 cormorants, 2 herons/bitterns, 1 stork, 3 ducks, 1 crake, 1 jacana, 1 avocet, 2 gulls and 1 weaver) appear to have increased; further, the three new breeding records for Delhi (2 warblers and 1 bush-chat) are all of marsh-haunting species.

On the other hand, 6 wetland species (3 storks/ibis, Great Stone Plover, Little Tern and Indian Skimmer) have decreased; 3 former breeders (2 bitterns and 1 rail) were not re-recorded. Further, 5 wetland species which were formerly considered rare or irregular visitors (2 snipe, 1 pelican and 2 storks/ibis) were also not recorded.

The most significant declines are of the large storks (Black-necked and Greater Adjutant in particular) and the sand-bank nesting birds (Stone Plover, Little Tern and, especially, Skimmer). The latter have evidently been seriously affected by increasing disturbance along the Jamuna sand-banks, both by people and their animals, including stray dogs; no doubt, other breeding terns, pratincoles and plovers have been similarly affected, though no major decline is noticeable yet.

4. The decline of some of the passerines is striking; especially so for Marshall's Iora, 2 flycatchers (White-browed Fantail and Paradise), Chestnut-bellied Nuthatch, White-bellied Minivet, Spotted Grey Creeper and wintering Wheatears - all insectivorous species. The falling populations of many of these had been noted as early as the 1960's, and attributed to loss of indigenous acacia country. This loss has enormously accelerated since, with

expanding urbanisation, and most 'green' areas have been taken over by *Prosopis*. A massive increase in the House Crow population and consequent destruction of eggs and young may also be a factor. In spite of this, the decline of the White-browed Fantail Flycatcher and Paradise Flycatcher, species which have adapted to modified habitats elsewhere, remains enigmatic.

5. Two passage migrants, Rosy Pastor and Redheaded Bunting, appear to have declined sharply in numbers. The former was regular and abundant on both passages over Delhi at least uptil the 1960s; the latter was described as fairly common in spring and rare in autumn. Now both are definitely unusual. There seems to be a change in the status of the Greenish Leaf Warbler too - formerly recorded only on autumn passage, it now appears regularly in spring. While changes in the status of the Redheaded Bunting and Greenish Leaf Warbler could possibly be ascribed to a reduction in grain cultivation in the immediate neighbourhood of the city and to increase in planted tree cover within city limits respectively, the case of the Rosy Pastor is strange.

6. On the positive side, Delhi still remains a great birdwatching locality. Most waders and ducks have maintained their numbers, and their concentrations in winter can be impressive, as can those of raptors; the Jamuna river appears to be an important migratory pathway, especially in early summer, when several species, normally unusual or rare so far inland, may occur; and the continued presence of species such as Painted Sandgrouse, within city limits as it were, is remarkable. But green areas and the thorn scrub countryside continue to be encroached upon, the river is getting more and more polluted and the vastly increased traffic across the Okhla barrage and the inevitability of a new bridge being constructed across some of the best bird areas near Okhla to cater to the increasing urbanisation across the Jamuna, will all take their toll. It will be interesting to see how the birdlife fares.

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BURROW MORPHOLOGY OF FIELD RODENTS[1]

P. Neelanarayanan, R. Nagarajan and R. Kanakasabai[2]

Key words: burrow morphology, *Bandicota bengalensis, Mus booduga, Millardia meltada, Tatera indica,* soil pluggings, rodent pests

This communication describes the burrow morphology of four species of field rodents, namely *Bandicota bengalensis, Mus booduga, Millardia meltada* and *Tatera indica* of the cauvery delta, Tamil Nadu. The burrow entrances of *B. bengalensis* had a large quantity of heaped soil and large sized pebbles while those of *M. booduga* had a small quantity of heaped soil with small sized pebbles. The burrows of *M. meltada* went vertically downwards with no soil heap. *T. indica's* burrows usually had more than one entrance and the burrows were slanted (approximately 45°) with a small quantity of heaped soil. The burrow morphology of rodent species did not vary with the crop fields but the diameter of their burrow entrance was significantly different.

INTRODUCTION

Four species of rodents, namely *Bandicota bengalensis, Mus booduga, Millardia meltada,* and *Tatera indica* cause extensive damage to paddy and pulses grown in Thanjavur District, Tamil Nadu (Jayaraman and Velayutham 1977, Sivaprakasam 1988). A comprehensive knowledge of the burrow morphology of rodents is useful, since it can be used to distinguish them from other burrowing animals, for population estimation, placing poison baits and also for physical control. The nature of the burrow entrances of field rodents have been reported for *B. bengalensis,* (Barnett and Prakash 1975, Sridhara 1976, Sivaprakasam 1988), *M. booduga* (Sivaprakasam 1988), *M. meltada* (Urs 1968, Sivaprakasam 1988) and *T. indica* (Chandrahas and Krishnaswamy 1974, Barnett and Prakash 1975, Sivaprakasam 1988). No published information on the nature of burrow entrances of field rodents are available from Cauvery delta, Tamil Nadu, and hence the present investigation.

METHODS

The study was carried out in Paddy, Sugarcane, Soyabean, Cotton fields and barren lands of approximately 2 hectares each in Mannampandal, Kanjanagaram and Natham Villages of Nagapattinam, Quaid-e-Milleth district, Tamil Nadu (11° 2' N and 79° 49' E) during February and March 1993 and April 1994. In the selected crop fields, structure and nature of burrow entrances of field rodents were studied visually and noted down. The available quantity of soil heaps and size of pebbles at the burrow entrances of *B. bengalensis* and *M. booduga* were compared visually. Simultaneously, the diameter of the burrow entrances of field rodents in different crop fields was measured with the help of a divider whose length was read from a calibrated scale and recorded. The difference among the diameter of the four species of rodents were tested statistically by employing Student's "t" test following the method suggested by Sokal and Rohlf (1981).

The plugged (burrow entrance) and unplugged burrows of *B. bengalensis* and *M. booduga* and unplugged burrows of *M. meltada* and *T. indica* were excavated, the animal's presence and absence in the respective burrows were recorded.

RESULTS AND DISCUSSION

Our observations revealed that each rodent species had a typical pattern of burrow entrance. The burrow entrances of the lesser bandicoot rat, *B. bengalensis* had a large quantity of heaped soil with large sized pebbles whereas the Indian field mouse,

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M. booduga's burrow entrances had small quantity of heaped soil with small sized pebbles. Studies of Barnett and Prakash (1975) and Sridhara (1976) also confirm the presence of a heap of soil at the burrow entrances of *B. bengalensis* in Rajasthan and Karnataka, respectively. Similar observations have been made by Sivaprakasam (1988) for *B. bengalensis* and *M. booduga* in Tamil Nadu. Besides, the burrows of both the species were located at the sides of the bunds.

The diameter of the burrow entrances of these two rodent species is another scale for identifying the occupant species. The burrow entrance diameter of *B. bengalensis* (overall range: 4.6 - 7.1 cm) was larger than that of *M. booduga* (overall range: 1.8 - 2.6 cm) (Table 1). The difference between the burrow entrance diameters of *B. bengalensis* and *M. booduga* is statistically significant ($P < 0.05$, Table 1).

Both the rodent species close their burrow entrances after entering into it. Sridhara (1985) has also reported similar main outlet plugging behaviour of *B. bengalensis* and *M. booduga* either with soil or grass during the day. The observed behaviour of these two rodent pests might be to prevent the entry of predators. In the present study, the number of burrow openings ranged from 1 to 3 for *B. bengalensis* and one for *M. booduga.* In contrast, Sridhara (1985) has observed 5 to 15 openings per burrow for *B. bengalensis.*

To confirm the presence of animals, the closed and open burrows, were excavated. In the closed

TABLE 1

DIAMETER (CM) OF THE BURROW ENTRANCE OF FIELD RODENTS IN DIFFERENT CROP FIELDS OF MANNAMPANDAL, KANJANAGARAM AND NATHAM VILLAGES OF NAGAPATTINAM QUAID-E-MILLETH DISTRICT, TAMILADU

	B. bengalensis		*M. booduga*		*M. meltada*		*T. indica*	
Name of the crop	$\bar{X}$ ± S.D.*	No. of burrow openings	$\bar{X}$ ± S.D.*	No. of burrow openings	$\bar{X}$ ± S.D.*	No. of burrow openings	$\bar{X}$ ± S.D.**	No. of burrow openings
Paddy	5.88 ± 0.66 (4.6 - 7.1)	1-3	2.14 ± 0.19a (1.9 - 2.5)	1	3.92 ± 0.35b,c (3.3 - 4.4)	1-2	—	—
Sugarcane	6.02 ± 0.59 (5.1 - 7.0)	1-2	2.16 ± 0.19a (1.9 - 2.5)	1	3.75 ± 0.34b,c (3.2 - 4.5)	1-2	—	—
Soybean	6.02 ± 0.58 (5.1 - 7.0)	1-3	2.1 ± 0.26a (1.8 - 2.5)	1	3.76 ± 0.35b,c (3.2 - 4.4)	1-2	—	—
Cotton	6.04 ± 0.52 (5.1 - 6.7)	1-2	2.1 ± 0.23a (1.8 - 2.6)	1	4.01 ± 0.19b,c (3.8 - 4.3)	1-2	—	—
Barren land	—		—		—		7.81 ± 1.05d (6.5 - 10.0)	2-3

* Mean of ten individual observations.

** Mean of fifteen individual observations.

a. Significant difference between the burrow diameters of *B. bengalensis* and *M. booduga.*

b. Significant difference between the burrow diameters of *B. bengalensis* and *M. meltada.*

c. Significant difference between the burrow diameters of *M. meltada* and *M. booduga.*

d. Significant difference between the burrow diameters of *T. indica* and *B. bengalensis, M. meltada* and *M. booduga.*

(Student's "t" test at 5% level)

Figures within the parenthesis indicate the range of the respective values.

burrows of *B. bengalensis* and *M. booduga* the animals were present while they were absent in the unplugged burrows (Table 2). Of the 114 closed burrows of *B. bengalensis* excavated, 112 were occupied. On the other hand, of the 52 open burrows of *B. bengalensis* excavated, none was found to be occupied. Similarly, 48 closed burrows of *M. booduga* were excavated, of which 47 burrows were occupied by this rodent species while the examination of 22 open burrows revealed their complete absence (Table 2).

The burrow entrance of soft furred field rat, *M. meltada* was characterised by the absence of a heap of soil and the burrow goes vertically downwards and its entrance remained open. The number of burrow openings per burrow system ranged from one to two. Similar observations have been made for *M. meltada* by Sivaprakasam (1988). Contrary to this, Urs (1968) has observed small stones, pebbles and mud pot pieces around the burrow openings of this rodent species. The burrow entrance diameter of *M. meltada* ranged from 3.2 to 4.5 cm.

The difference between the burrow entrance diameter of *M. meltada* and *B. bengalensis, M. booduga* and *T. indica* were statistically significant ($P < 0.05$; Table 1). Seventy nine burrows of *M. meltada* were dug, of which 30 burrows were found occupied (Table 2).

Interestingly, in all the crop fields under study these three species of rodent pests had similar burrow morphology. The diameter of the burrow entrances of *B. bengalensis, M. booduga* and *M. meltada* did not vary significantly among the crop fields studied (Table 1). It is also interesting to mention here that burrows of *T. indica* were not observed in the bunds of crop fields.

The Indian gerbil, *T. indica*'s burrows were observed only in the barren lands and they had more than one opening (range: 2 to 3) adjacent to each other and the distance between them was nearly 0.5 to 1.0 m. The burrows were slanted (roughly 45°) and the entrances had a small heap of soil. Our observations of more than one burrow openings are compatible with the observations of Barnett and Prakash (1975), Pingale *et al.* (1967), George *et al.* (1982) and Sivaprakasam (1988). The diameter of burrow entrance (overall range: 6.4 - 10.0 cm) was significantly larger than that of the other three species of rodent pests ($P < 0.05$, Table 1). Of the 75 burrows of *T. indica* opened, 18 burrows were occupied by the species.

TABLE 2

FIELD RODENTS' BURROW OCCUPANCY BASED ON THE NATURE OF BURROW ENTRANCE IN DIFFERENT CROP FIELDS

Rodent species	Nature of burrow entrance	No. of burrows excavated	No. of burrows occupied	Percentage of occupation
Bandicota bengalensis	Plugged	114	112	98.0
	Unplugged	52	0	0
Mus booduga	Plugged	48	47	98.0
	Unplugged	22	0	0
Millardia meltada	Unplugged	79	30	38.0
Tatera indica	Unplugged	75	18	24.0

Thus, from the present study it is inferred that the burrow entrances of the four species of field rodent pests of Cauvery delta are highly species specific. Their burrow morphology did not differ among the crop fields. However, the burrow entrance diameter of four species differed significantly from one another. Further, with the help of these keys one can identify the occupant rodent species under field conditions.

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF BOMBAY NATURAL HISTORY SOCIETY - 37: DICAEIDAE, NECTARINIIDAE AND ZOSTEROPIDAE

Humayun Abdulali and Saraswathy Unnithan

(Continued from Vol. 92 (3): 359)

This part deals with 666 specimens of 46 species and subspecies and 2 extralimitals, up to SYPNOSIS No. 1937 in the INDIAN HANDBOOK (10:61) and No. 23491 of the Society's register. We do not have specimens of 7 forms (2 species and 5 subspecies) in our collection. As in the earlier parts (34, 35 and 36), the bulk of the work has been done by S.U. with H.A cursorily checking to refine the original work.

1892, 1894. **Dicaeum agile agile** (Tickell) (Borabhum and Dholbhum) Indian Thickbilled Flowerpecker 3:435

35: 15 males 12 females 8 o?

1 Kalka, N.W.H; 1 Jabli, Bhagat State, N.W.H; 1 Baragam, Gonda Dist., U.P.; 1 Rajputtee, Saran, Bihar; 2 Dediapada, Rajpipla State, 1 Nadiad Dt., Kaira, Gujarat; 1 Jaithari, Bhopal, 2 Paryat, Jabalpur, C.I.; 1 Wada, Bhiwandi, Thana, 1 Khandala, 1 Kihim, Alibag, Kolaba; 2 Deviwadi, Tal, Rajapur, 3 Ratnagiri; 1, Kadra, 1 N. Kanara; 1 Cherangodu, Gudalur Taluk, Nilgiri; 1 Wynaad, 1 Maraiyur, Travancore; 3 Badrama, 2 Barkot, 1 Farahabad, Hyderabad; 1 Banupratappur, Kanker, C.P., 1 Bhopalpatnam, Bastar Dt., C.P., 1 Kameli, Bailadila, Bastar Dt. C.P.; 3 *N' Krang, Upper Burma.*

Three specimens, all unsexed, from N'Karang in upper Burma appear different from the others in so far as they are darker above and all show a dirty wash on the underparts which separates them from all the others. Was this the form described as *modestum* by Hume?

Measurements on p. 247.

1893. **Dicaeum agile zeylonense** (Whistler) (Kumbalgamuwa, Ceylon) Ceylon Thickbilled Flowerpecker 3.435

nil.

1895. **Dicaeum chrysorrheum chrysochlore** Blyth (Arracan) Yellowvented Flowerpecker 3: 426,427

6: 3 males 1 female 2 o?

1 Rupachena, Cachar, 2 North Cachar; 1 *Ataran, Burma*, 2 *Kamaing, Upper Burma.*

Measurements on p. 247.

1896. **Dicaeum melanoxanthum** (Blyth) (Nepal) Yellowbellied Flowerpecker 3: 439

nil.

1897. **Dicaeum vincens** (Sclater) (Ceylon) Legge's Flowerpecker 3: 425

nil.

1898. **Dicaeum trigonostigma rubropygium** Baker (Mergui) Orange-bellied Flowerpecker 3: 425

1 male from Singapore.

Measurements on p. 247.

1899. **Dicaeum erythrorhynchos erythrorhynchos** (Latham) (India) (restricted to Bombay by Baker) Tickell's Flowerpecker 3: 432

33: 16 males 11 females 6 o?

1 Badmain, Bajji State, N.W.H.; 1 Dehra, Dehra Dun Dt.; 1 Ranibagh, U.P.; 3 Baghownie, Tirhut; 1 Songadh, Navsari Dt; 1 Dediapada, Rajpipla State, 1 Pandwa, Surat Dangs, Gujarat; 1 Pali Hill, Bandra, 1 Trombay Island, 1 Gorbunder, 1 Andheri, 1 Borivli, Salsette, Bombay; 1 Khandala; 1 Durgawadi, 1 South Konkan, 1 Kadra, N. Kanara, 3 Karwar; 2 Jabalpur, C.I., 1 Bhanupratappur, Kanker, 1 Chota Dongar, 1 Darba, 2 Kameli, Bailadila, Bastar Dt., C.P.; 2 Badrama, Bamra, Orissa; 1 Sankrametta, 1 Jeypore Agency, Vizagapatnam; 1 no locality.

Measurements on p. 247.

1900. **Dicaeum erythrorhynchos ceylonense** Babault (Boista, Ceylon) Ceylon Small Flowerpecker 3: 433

nil.

1901. **Dicaeum concolor olivaceum** Walden (Tounghoo) Plaincoloured Flowerpecker 3:430

7: 3 males 3 (2 juv.) females 1 o?

1 Hungrum, 2 N. Kachar; 2 Lait Kensew, Khasia Hills; 1 *Prome Dt.*; 1 *S.E. of Maymyo, Burma.*

The 2 juveniles both have a light coloured bill.

Measurements on p. 247-248.

1902. **Dicaeum concolor concolor** Jerdon (Malabar Coast) Nilgiri Flowerpecker 3: 439,430

19: 7 males 7 (1 juv.) females 5 o?

1 Savantwadi; 1 Canacona, 2 Molem, Goa; 1 Balamani; 3 Kadra; 1 N. Kanara; 2 Karwar; 1 Attikan Estate, Mysore; 1 Kotagiri, 2 Cherangodu, Gudalur, 1 Kotamalai, 1 Avalanche, Nilgiris; 1 Peerumedu, 1 Periyar, Travancore.

This has been recorded as far north as Mahabaleswar by BNHS ringing camps. Though 1901 & 1902 are separately marked and listed We can see no differences between the two in size or colour. The female marked juvenile has pale bill.

Measurements on p. 247-248.

1903. **Dicaeum concolor virescens** Hume (Neighbourhood of Port Blair, Andamans) Andaman Flowerpecker 3: 431

4: 1 male 3 females

1 Bakultala, Middle Andaman; 1 Sippighat, 2 Wrightmyo, S. Andaman.

Measurements on p. 247-248.

1904. **Dicaeum cruentatum cruentatum** (Linnaeus) (Benghala) Scarletbacked Flowerpecker 3: 421

12: 8 males 3 females 1 o?

1 Longview, Darjeeling; 1 Lakhimpur, U.Assam, 3 Dibrugarh, 1 Goma Reserve, Goalpara, Assam; *4 Kani, Lower Chindwin, 1 Thayetmyo Dt., Burma*; 1 no locality.

Measurements on p. 248.

1905. **Dicaeum ignipectus ignipectus** (Blyth) (Sangau, Lushai Hills) Firebreasted Flowerpecker 3: 427

28: 18 males 9 females 1 o?

3 Basantpur; Bhajji St; 5 Simla Hills, N.W.H; 1 Kumaon, 1 Dhanaulti, Mussooree; 1 Tung, Sikkim, 3 Rinchinpong, 1 Temi, W. Sikkim; 1 Darjeeling; 1 Dening, Lohit Valley, N.E. Assam; 2 Honka, W. Bhutan, 1 Batase, 1 Khosela, 1 Shamgong, C. Bhutan; 1 Rongtong; 1 Narphong, 1 Wamrong, 1 Tashigong, 1 Deothang, E.Bhutan, 1 Kangpokpi, Manipur.

There are black streaks on the belly in males. The males show appreciable variation in the shape of the red on the breast. 2 females Nos. 25564 & 25567 from Honka, W. Bhutan have white chin though they are not smaller than the others.

Measurements on p. 248.

1906. **Anthreptes singalensis rubinigentis** (Baker) (India restricted to Cachar) Rubycheek 3: 370

5: 4 males (2 by plumage) 1 female

1 Gaylegphug, C. Bhutan; 1 Rupachena, Cachar; 1 Cherapunji, Khasi Hills; 1 *Upper Burma*, 1 *Rangoon*.

In the absence of any bird marked *lepida* they are all placed under *rubinigentis*.

The female bird marked with a query has a pale rufous on the chin and throat but lacks the green above and the yellow below.

Measurements on p. 248.

1907. **Nectarinia zeylonica sola** (Vieillot) (Pondichery) Indian Purplerumped Sunbird 3: 406

45: 28 males (2 by pl.) 15 females 2 o?

1 Thana, 1 Uran, 1 Santacruz, 2 Bandra, 3 Andheri, 2 Malabar Hill, 1 Colaba, Bombay; 2 Poona, Deccan, 2 Satara; 1 Canacona, Goa; 1 Kumta, N. Kanara, 6 Karwar, 2 Ulavi, Sorab Taluk, Shimoga, Mysore; 1 Thekkadi, Travancore; 1 Jamestown, Kanyakumari Dt.; 1 Madras, 1 Mettupalayam, 1 Kurumbapatti, Salem Dt.; 1 Koduru, 1 Seshachalam Hills, S. Cuddapah, 1 Nallamalai Range, S. Kurnool, 1 Kumbum Valley, Kurnool Dt.; 2 Kuldiha, Nilgiri; 2 Badrama, Bamra, 1 Orissa; 1 Calcutta; 3 Bhanupratappur, Kanker; 1 Geedam, 1 Dantewara, Bastar Dt., C.P.

Measurements on p. 248.

1908. **Nectarinia zeylonica zeylonica** (Linnaeus) (Ceylon) Ceylon Purplerumped Sunbird 3: 406

nil.

We have no specimens from the type locality Ceylon, of this form which has almost the same size wing 50-57, in *sola* 51-58.

1909. **Nectarinia minima** (Sykes) (Ghauts, Dukhun) Small Sunbird 3: 405

17: 11 males (1 by pl.) 6 females

2 Matheran, 2 Khandala, Western Ghats; 1 Molem, 1 Valpoi, Goa; 3 N. Kanara, 1 Kanara; 1 Perrengodu, 2 Cherangodu, 2 Morappalam, 1 Kodanadu beyond Kotagiri, Nilgiris; 1 Shembagnur, Palni Hills.

Measurements on p. 248.

1910. **Nectarinia sperata brasiliana** (Gmelin)

(Brazilia *in errore* = Java) Van Hasselt's Sunbird 3: 400

3: 2 males 1 female

2 Rema Tea Estate, 1 S. Sylhet.

Measurements on p. 248.

1911. **Nectarinia lotenia hindustanica** (Whistler) (Kumta, North Kanara) Indian Maroonbreasted Sunbird 3:394

15: 9 males 6 females

1 Tulsi Lake, 2 Borivli, Salsette, 1 Santacruz, Bombay; 1 Molem, Goa; 2 North Kanara, 3 Karwar, Kanara; 1 Nallamalai

Range, S. Kurnool, 1 Kurumbapatti, Salem Dt., 1 Gudalur, Nilgiris, 1 Kodikkarai, Point Calimere; 1 no locality.

Measurements on p. 248.

1912. **Nectarinia lotenia lotenia** (Linnaeus) (Ceylon) Ceylon Maroonbreasted Sunbird 3: 394

nil.

1913. **Nectarinia jugularis andamanica** (Hume) (Andaman Group) Andaman Olivebacked Sunbird 3: 404

12: 8 (1 by plumage) males 4 females (3 by pl.)

1 Landfall Island, 1 Aerial Bay, Diglipur, N. Andaman; 2 Bakultala, Middle Andaman, 2 Wrightmyo, S. Andaman, 6 Narcondam.

Measurements on p. 249.

1914. **Nectarinia jugularis klossi** (Richmond) (Great Nicobar) Nicobar Olivebacked Sunbird 3: 401-2

10: 5 males 5 females

3 Nancowry, 2 Trinkut, 1 Camorta, Central Nicobars, 4 Campbell Bay, C. Nicobar.

Measurements on p. 249.

1915. **Nectarinia jugularis proselia** (Oberholser) (Car Nicobar Is.) Car Nicobar Olivebacked Sunbird 3:401

9: 7 males 2 females

2 Perka, 7 Car Nicobar.

Measurements on p. 249. .

EL. **Nectarinia jugularis flammaxillaris** Blyth (Tenasserim)

1 male (by plumage) from *Ingabu, Henzada Dt., Burma.*

(See note on p. 297).

1916. Nectarinia asiatica brevirostris Blanford [(Persian) Baluchistan near Jalk] Sind Purple Sunbird 3: 399

5: 4 males 1 female

1 Chaharbar, Persian Gulf, 1 Mand, 1 Pahrah, 17 m E of Bampur, 1 Peshawar, N.W.F.P., 1 no locality.

In addition to the slightly smaller size the males have a tinge of purple on the head and nearby areas of the upper parts. The size can be included in the range of size and it may be noted that Koelz in his papers on the Birds of Londa Dist., North Kanara, has named his birds as "*brevirostris*".

Measurements on p. 249.

1917. Nectarinia asiatica asiatica (Latham) (India = Gurgaon) Indian Purple Sunbird 3: 396

91: 68 males 23 females

1 Jabli, 1 * Koti, 2 Bhagat St., 2 Solon, Simla Hills (?), 2 Sardar River, 1 Jallander, 2 Jagadhri, 2 *Ambala, 2 Meerut, 1 Bulandshahr, 5 Delhi, 1 Hamawas Lake, Pali Dt., 2 Bharatpur, Rajasthan, 1 Deesa, Palanpur, 1 Radhanpur, 1 Mandvi, 1 Kutch, 1 Dabka, Baroda, 6 ***Bhavnagar, 1 Badarwas, Gwalior St., 1 Jabalpur, 1 *Pimpri, Surat Dangs, 1 *Dohad, 1 Kihim, Raigad dt., 1 Murbad, Kalyan, Thana, 1 Shil, Thana, 1 Pawai, 3 Godbunder, 2 Bhandup, 2 Andheri, Salsette Is; 3 Khandala, 1 Madhmeswar, Niphad, Nasik, 3 Jalgaon, E. Khandesh, 2 Satara, 1 Molem, Goa, 1 Anshi, 2 Kadra, Karwar, 1 N. Kanara, 1 Ulavi, Shimoga, Mysore, 1 Gudalur, Nilgiris, 1 Padagiri, Nelliyampathi Hills, Cochin, 1 Thekkady, Travancore, 1 Madura, 1 Foothills of Palni, 1 *Manalur, 1 Sheshachalam Hills, S. Cuddapah, 1 Cumbum Valley, Kurnool Dt., 1 Sankrametta, 2 Anantgiri, Vizag, 2 Kameli, Bailadila, 1 Geedam, 1 Konta, Bastar; 2 Bhanupratappur, Kanker, 1 Gurguria, Simlipal Hills, 1 Keonjhargarh, 2 *Koira, Bonai, 1 Barkot, Bamra, 1 Orissa, 1 Baghownie, Darbhanga Dt., 1 Rampur, Bihar, 1 no locality.

* Males marked thus have a touch of purple in their upper plumage. Female No. 18431 from Bhagat State, N.W. Himalayas is mostly yellow below and may be a juvenile as also those with grey chins. Several with a black line down the throat are marked female, presumably in error. The two from Solon, were collected by Mr H. M. Whittel, whose postal address is recorded as Solon.

Measurements on p. 249.

1918. **Nectarinia asiatica intermedia** (Hume) (Tippera) Assam Purple Sunbird 3:398

13: 9 males 4 females

1, S.Sylhet, Assam, 1 Singhaling; 1 *Maymyo*, 3 *Kani, Lower Chindwin*, 1 *S. Shan State*, 1 *Yatsanh, S. Shan States*, 1 *Thayetmyo Dt.*, 1 *Inbin, Henzada Dt.*, 1 *Sandoway*, 1 *Prome, L. Burma*, 1 *Daudaung, Ataran, Burma.*

Measurements on p. 249.

1919. **Aethopyga gouldiae gouldiae** (Vigors) (Himalayan mountains = Simla - Almora area) Mrs Gould's Sunbird 3: 385

12: 9 males (1 juv.) 3 females

1 Simla, 5 Koti St., N.W.H., 1 Dhanaulti, Mussooree, 1 Pandukeswar, Badrinath, Garhwal, 1 Kurseong, Sikkim, 1 Deothang, 1 Rongtong, 1 Wamrong, East Bhutan.

The juvenile male (31st August 1927 from Simla) is marked with yellow on the belly while the three females have traces of pale yellow below. The male (Kurseong, Sikkim, 9th July 1944) has lines of white spots on each side of the black on the chin.

Measurements on p. 249.

1920. **Aethopyga gouldiae isolata** Baker

(Manipur) Manipur Yellowbacked Sunbird 3: 385, 386

nil.

1921. **Aethopyga gouldiae dabryii** (Verreaux) (Tu-tsien-leou, Setchuan O.) Dabry's sunbird 3: 387

4: 1 male 3 o?

1 *Taunggyi*, 1 *Lahatznshi*, 1 *Loi Kan*, 1 *South Shan States, Burma*

Measurements on p. 249.

1922. **Aethopyga nipalensis horsfieldi** (Blyth) (Himalayas = Mussoorie) Western Yellowbacked Sunbird

3: 3 (1 by pl.) males

1 Bhim Tal, Kumaon, 2 Naini Tal

Measurements on p. 249.

1923. **Aethopyga nipalensis nipalensis** (Hodgson) (Nepal) Nepal Yellowbacked Sunbird 3: 391

4: 3 males 1 o?

1 Darjeeling, 1 Jorepekri, Jalpaiguri, 1 Tung, Sikkim, 1 Nepal Valley.

Measurements on p. 249.

1924. **Aethopyga nipalensis koelzi** Ripley (Dening-Dreyi trail, Mishmi Hills, NE. Assam) Eastern Yellowbacked Sunbird 3:391

18: 10 males 8 females

1 Phuntsholing, 4 Gedu, West Bhutan, 2 Shamgong, Central Bhutan, 3 Wamrong, 1 Narphong, East Bhutan, 2 Singtam, Teesta Valley, 2 Martham, Rongni Valley, 2 Chirrapunji, 1 Kalaktang, Arunachal Pradesh.

Measurements on p. 249.

1925. **Aethopyga saturata saturata** (Hodgson) (Nepal) Himalayan Blackbreasted Sunbird 3: 388

12: 10 males 2 females

1 Kumaon, 1 Garhwal, 2 Pershoke, Sikkim, 1 Darjeeling, 1 Singtam, Teesta Valley, 2 Tama, Central Bhutan, 2 Gomchu, 1 Deothang, East Bhutan, 1 Dening, Lohit Valley, NE. Assam.

Measurements on p. 250.

1926. **Aethopyga saturata assamensis** (McClelland) (Assam) Assam Blackbreasted Sunbird 3: 388

13: 7 males 5 females 1 o?

5 Laitkensew, Khasia Hills, 1 Kohima, Naga Hills, 1 Hai Bum, 1 Kalaktang, 1 Miao, 2 40th mile from Miao, Deban Div., Arunachal Pradesh; 1 *N. Krang, Upper Burma*, 1 *Jungtang, Burma.*

assamensis were included with *saturata* in Stuart Baker's Fauna and except for 2 skins dating as far back as 1906 from the Khasia Hills we cannot separate them either. These have lost the green on the head which now appears purple. They are however listed separately according to distribution.

Measurements on p. 250.

1927. **Aethopyga siparaja seheriae** (Tickell) (near Seheria in Borabhum) Indian Yellowbacked Sunbird 3: 378, 380

35: 26 males 6 females 3 o?

2 Kalka, 1 Jabli, 2 Bhagat St., 1 Simla Hills, N.W.H.; 3 Dehra Dun 1 Bhim Tal, 2 Ranibagh, Kumaon, 1 Bans Behari, Nepal, 1 Pershoke, Sikkim, 1 Darjeeling, 1 Backsa Duar, Jalpaiguri Dt., 1 Kangpokpi, Manipur, 2 Rupachena, Cachar, 3 Badrama Bamra, Orissa; 1 Cuclar? 2 *Upper Burma*, 4 *Kamaing, Upper Burma*, 2 *Singhalig, Burma*, 1 *Hsi paw, N. Shan States*, 1 *Loilong, S. Shan States*, 2 *North of Maymyo, Burma.*

Of the 6 females all except one and two of three unsexed have a slight wash of red on the chin.

Measurements on p. 250.

1928. **Aethopyga siparaja labecula** (Horsfield) (Assam) Assam Yellowbacked Sunbird 3: 378

10: 5 males 5 females

1 Batase, 1 Mangdechu, Central Bhutan, 1 Deothang, E. Bhutan, 1 Laitkensew, Khasia Hills, 2 chirrapunji, 1 Reena Tea Estate, S. Sylhet, 1 Margherita, 1 Mornai Tea Estate, 1 Goalpara, Assam.

Measurements on p. 250.

1929. **Aethopyga siparaja vigorsii** (Sykes) (Ghauts, Dukhun) Vigors's Yellowbacked Sunbird 3:381

10: 8 males 2 females

1 Songadh, Navsari Dt., 1 Juna, Rajpipla, 1 Waghai, Surat Dangs, 2 Bhowra; 2 God bunder, Salsette Is, 1 Matheran, 2 Khandala, W. Ghats.

One female from Waghai, Surat Dangs (sexed by Sálim Ali, on 24 March 1948) has a patch of red on the throat and upper breast. Another male (6 April 1885, Matheran) has a yellow streak running up the middle of the upper breast through the chin to the base of the bill.

Measurements on p. 250.

1929a. **Aethopyga siparaja nicobarica** Hume (Kondul) and Meroe Islands, Nicobar group) Nicobar Yellowbacked Sunbird

6: 5 males 1 female

4 Campbell Bay, 2 Pilu Bhabli, Great Nicobar.

The wing of the female (45 mm) is not

mentioned in the HANDBOOK and the bill of the male is a little smaller than in *vigorsii.*

Measurements on p. 250

EL. **Aethopyga siparaja cara** (Hume) (Tenasserim)

1 male from *Cara Hills, East of Moulmein, Burma.*

Forehead and crown badly damaged, no date nor collector's name.

1930. **Aethopyga ignicauda ignicauda** (Hodgson) (Nepal) Firetailed Yellowbacked Sunbird 3: 383

15: 9 males 2 females 4?

1 Kalka, Ambala Dt. Punjab, 1 Kat, Nepal, 1 Chungthang, Lachung, 1 Rinchinpong, W. Sikkim, 1 Sikkim, 2 Kurseong, 6 Phalut, Darjeeling, 1 Darjeeling, 1 Shamgong, C. Bhutan.

All the nine males are in non-breeding (eclipse) plumage.

The two females differ from the males by the absence of both yellow and red anywhere on the underparts. The HANDBOOK states that the females are olive, with more yellow on rump and belly.

Measurements on p. 250.

EL. **Aethopyga ignicauda flaviscens** Baker Mt. Victoria (Chin hills) Rippon's Firetailed Sunbird 3:384

One unsexed skin in full male breeding plumage, from Mt. Victoria.

1931. **Arachnothera longirostris longirostris** (Latham) Bengal (restricted to Sylhet by Baker) Little Spiderhunter 3:418

19: 11 males 5 females 3 o?

1 Anshi, 1 North Kanara, 1 Chezwad, 1 Rajampara, Panthalam Hills, 1 Thekkady, Travancore, 1 Wangasara, Andhra Pradesh, 1 Lamasinghi, Vizag, 2 Rupachena, Cachar, 1 Laitkensew, Khasia Hills, 1 Rema Tea Estate, S. Sylhet, 2 Margherita, 1 Dibrugarh, Assam, 1 Arunachal Pradesh; 2 *Upper Burma,* 1 *Gamonchaung,* 1 *Kyibin, Henzada Dt., Burma.*

Measurements on p. 250.

1932. **Arachnothera magna magna** (Hodgson) (Nepal) Streaked Spiderhunter 3:414

23: 14 males 5 females 4 o?

3 Sevoke, Darjeeling; 1 Samchi, W. Bhutan, 2 Mangdechu, C. Bhutan, 1 Deothang, E. Bhutan, 1 Bhutan Duars, 1 Laitkensew, Khasia Hills, 1 Guryong, 3 Hungrum, 1 N. Cachar, 1 Chera, Chirrapunji, 1 Margherita, 1 Kurbia Tea Estate, 1 Sadiya, Upper Assam, 1 Namorah, Arunachal Pradesh. 1 *Taumai, Upper Burma,* 1 *Nyaungchi Sauk, Taungup, Prome Dt., Burma,* 1 *Tangte*? 1 no locality.

Measurements on p. 250.

1933. **Zosterops palpebrosa palpebrosa** (Temminck) (Bengal) Indian White-eye 3: 358-61

68: 39 males 19 females 10 o?

1 Kashmir, 1 Malakand, N.W.F.P., 2 Shikohpur, Jallander, 11 Simla, 1 Koti State, 1 Bavlowgunj, Mussooree, 1 Kalka, 1 Ambala, 1 Nepal, 1 Gurna, 1 Almora, U.P., 1 Bulandshahar, U.P., 2 Harunabad Bahawalpur St., 1 Sunda Hills, Jodhpur, 1 Jawahar, Jaswantpura Dt., Jodhpur, 1 Deesa, Palanpur State, N. Gujarat, 1 Dalkhania, Amreli Dt., Kathiawar, 1 Dabka, Baroda, 1 Vaghjipur, Mehsana Dt., 1 Mahal, 1 Pimpri, Surat Dangs, 2 Ambakona, M.P., 1 Narwar Fort, 1 Surawaya, Gwalior state, 4 Bhanupratappur, Kanker, 1 Geedam, 1 Golapally, Bastar Dt., C.P., 2 Pili, Melghat, 1 Chikalda, Berar, 1 Market, Bombay, 1 Mehda, Satara, 1 Savantwadi, 1 Nilpara, Jalpaiguri, Bengal, 1 Hungrum, N. Cachar, 1 Pun, Khahet, 2 Baghownie, Darbhanga, 2 Mangdechu, 1 Tama, 1 Gaylegphug, C. Bhutan, 1 Gomchu, 1 Tashigong, E. Bhutan, 1 Martam, Rongini Valley, 4 Dibrugarh, 1 Sadiya, U. Assam; 1 *N. Krang, Upper,* 1 *Taunggyi, Burma.*

Z.P. palpebrosa specimens, when arranged geographically N. Western birds in common have an olive green tinge on the upper parts, N. Eastern ones are more brownish above and birds from southern Gujarat, Maharashtra, M.P., and Orissa, are more yellowish above.

Measurements on p. 251.

1934. **Zosterops palpebrosa salimalii** Whistler (Farahabad, S.E. Hyderabad) Andhra White-eye 3: 358

22: 13 males 7 females 2 o?

2 Badrama, Bamra, 1 Mahendragiri, 1 Kanta, Keonjhar, 1 Tikarpara, Angul Dt., Orissa, 2 Anantagiri, 3 Sankrametta, Vizagh, 1 Kaulas, Nander Dt., Hyderabad, 3 Nallamalai Range, S. Kurnool, 1 Yellandu, Warangal Dt., 3 Shevaroy Hills; 2 Singara Rd., Gudalur Tk, 1 Anaribetta, 1 Edubuthi, Billigirirangan Hills.

All the specimens were identified by Dr. Sálim Ali and Whistler. But from even a cursory examination appear to need a radical change.

2 from Gudalur Taluk, Nilgiris (900 m) and another two from the Billigirirangan Hills were listed in *nilgiriensis,* but they are distinctly *salimalii* and have been included there.

Measurements on p. 251.

1935. **Zosterops palpebrosa nilgiriensis** Ticehurst (Coonoor) Nilgiri White-eye 1: 358

7: 3 male 2 females 2 o?

1 Ootacamund, 1 Kotagiri, 1 Coonoor, Nilgiris, 3 Shembagnur, Palnis, 1 Santanpara, Cardamom Hills.

Measurements on p. 251.

1936. **Zosterops palpebrosa nicobarica** Blyth (Nicobar Islands) Nicobar White-eye

12: 5 males 4 females 3 o?

1 Bamboo Flats, Andaman, 1 Bakultala, Middle Andaman, 2 S. Sentinel, S. Andaman, 4 Car Nicobar; 2 Nancowry, 2 Trinkut, Nicobar.

Some of them have a definitely larger bill and a small patch of yellow on the rump. Of the four with yellow on the rump 2 are from the S. Sentinel Island, 1 from Car Nicobar and the fourth from Trinkut Island. The only explanation is inter island movement, which can only be accepted by careful watching of ringed birds — until this is confirmed by regular movements to and fro, we have no option but to accept these differences in size and colour as variation within this same group.

Measurements on p. 251.

1937. **Zosterops ceylonensis** Holdsworth (Nuwara Eliya) Ceylon White-eye 3: 366

2: 1 female 1 o?

1 Nuwara Eliya, 1 Ceylon.

Darkest of all *Zosterops,* dark olive green above, head a shade darker, breast light olive green rather than yellow and abdomen almost grey instead of white, undertail coverts light olive green contra to the yellow of other species.

Measurements on p. 251.

Part 37

	Wing	Bill	Tarsus	Tail
1892, 94. *Dicaeum agile agile*				
Males (15)	57-63 av. 61.4	6.5-8.5 av. 7.4	14-15 av. 14.5	29-31 av. 29.9
	(IH 55-65	from skull 10	14-15	31-34)
Females (12)	57-62 av. 58.6	6.5-7.7 av. 7.2	13-14.2 av. 13.6	27-30 av. 27.9
	(IH 58-64	from skull 9-10	13-14	27-30)
1895. *Dicaeum chrysorrheum chrysochlore*				
Males (3)	58, 58, 60	9, 9.8, 10.2	14.5, 15, 15	27, 27, 28
	(IH Male-Female 55-62	from skull 13-14	14-15	27-31)
Female (1)	54	9.6	15	26
1898. *Dicaeum trigonostigma rubropygium*				
Male (1)	45	11	13	20
	(IH Male-Female 45-51	9-10	*c.* 13	24-27)
1899. *Dicaeum erythrorhynchos erythrorhynchos*				
Males (16)	47-52 av. 49.2	9-10.4 av. 9.5	11-13.2 av. 12.1	21-25 av. 23.4
	(IH 46-52	from skull 11-13	11-13	22-27)
Females (11)	45-50 av. 47.3	9-11.5 av. 9.7	12-13.5 av. 12.3	20-24 av. 22.3
	(IH 46-50	from skull 11-13	*c.* 12	22-25)
1901-3. *Dicaeum concolor* subspp.				
Males				
olivaceum (3)	44, 46, 48	9.2, 9.7, 10	11.1, 11.8, 12	19, 20, 22
	(IH 43-48	From skull 11-12	—	21-23
concolor (7)	48-52 av. 49.4	9.2-11 av. 10	12.5-13.1	22-25
	(IH 45-52	From skull 12-13	*c.* 13	23-26)
virescens (1)	47	11	12.2	23
	(IH as in *concolor*)			

	Wing	Bill	Tarsus	Tail
Females				
olivaceum (3)	35, 40, 45	7, 7.2, 8.8	10.8, 11, 12	15, 17, 22
	(IH 42-4.5	from skull 11-12	—	*c.* 22)
concolor (7)	43-50 av. 46.3	8.5-11.5 av. 10.2	12.8-13 av. 12.9	21-24 av. 22.6
	(IH 44-52	from skull 12-13	*c.* 13	*c.* 25)
virescens (3)	44, 45, 46	10, 11, 11.1	12 (3)	21, 22, 22
	(IH as in *concolor*)			
1904. *Dicaeum cruentatum cruentatum*				
Males (8)	46-51 av. 49.1	9-10.2 av. 9.6	12-13.1 av. 13	23-28 av. 24.8
Females (3)	45, 45, 48	8.5, 9, 10	12.5, 12.8, 13.1	22, 22, 24
	(IH Male-Female 46-61	—	*c.* 13	25-28)
1905 *Dicaeum ignipectus ignipectus*				
Males (18)	47-51 av. 49.6	8-9.7 av. 8.6	12-14 av. 12.9	23-27 av. 24.8
	(IH 46-53	from skull 9-12	12-14	25-30)
Females (9)	46-49 av. 48.1	8-91 av. 8.5	12-14 av. 12.8	21-24 av. 22.5
	(IH 45-49	from skull 9-12	12-14	23-26)
1906. *Anthreptes singalensis rubinigentis*				
Males (2)	55, 57	13, 14	15, 16.5	37, 41
	(IH Male Female 52-55	from skull 14-17	15-17	41-43)
Female (1)	54	11.5	17.2	38
1907. *Nectarina zeylonica sola*				
Males (26)	52-59 av. 56.3	14-17 av. 15.1	15-18 av. 16.7	32-38 av. 33.8
	(IH 51-58	from skull 17-19	15-17	30-38)
Females (15)	51-55 av. 53.4	12.8-15.5 av. 14.3	14-16 av. 15.1	29-34 av. 31
	(IH 51-56	from skull 16-18	14-15	30-35)
1909. *Nectarinia minima*				
Males (10)	44-49 av. 47.1	11.5-14.5 av. 12.9	12-13 av. 12.6	26-30 av. 28.2
	(IH 44-50	from skull 14-17	12-13	27-31)
Females (6)	42-45 av. 43.6	10.5-12.5 av. 11.8	12-13 av. 12.4	23-25 av. 24.4
	(IH 42-46	from skull *c.* 15	*c.* 13	26-27)
1910. *Nectarinia sperata brasiliana*				
Males (2)	50, 50	12.7, 13.6	13, 13	28, 30
	(IH Males 45-50	from skull 16-17	12-13	28-29,
Female (1)	48	13.1	12	25
1911. *Nectarinia lotenia hindustanica*				
Male (9)	55-60 av. 57. 8	23-26.5 av. 24.8	15-16 av. 15.6	35-39 av. 37.7
	(IH 56-60	from skull 27-29	15-16	36-40)
Female (6)	53-57 av. 55.6	23-25.2 av. 24.1	14-16 av. 15.4	32-35 av. 33
	(IH 53-56	from skull 26-28	14-16	32-35)

	Wing	Bill	Tarsus	Tail
1913-15. *Nectarinia jugularis* subspp.				
Males				
andamanica (7)	53-60 av. 56	18.5-22 av. 20.2	14-16 av. 15.2	31-36 av. 33.8
	(IH 51-54	from skull 23-24	14	32-33)
klossi (5)	50-51 av. 50.2	16.5-20.5 av. 18.9	15-16 av. 15.6	30-34 av. 32
	(IH 50-53	from skull 21-23	14	30-32)
proselia (7)	49-51 av. 50.5	15-16 av. 15.8	14.5-17 av. 15.2	30-34 av. 32.2
	(IH 47-52	from skull 18-19	14	30-31)
Females				
andamanica (2)	50, 51, 54	18, 18.5, 20	15, 15.5, 16	30, 32, 34
klossi (5)	49-51 av. 49.4	16.5-19.5 av. 17.8	15.3-16.5 av. 15.9	29-31 av. 29.6
proselia (2)	47, 47	16, -	14.5, 15.5.	16, 28
	(IH 47-49	from skull 19	14	28)
1916-18. *Nectarinia asiatica* subspp.				
Males				
brevirostris (4)	54, 55, 55, 57	15, 16, 16, 16.1	15, 15, 15, 16	32, 33, 33, 35
	(IH Males 55-57	—	15-16	34-35)
asiatica (68)	52-60 av. 56.1	16-20 av. 17.5	15-16 av. 15.5	31-37 av. 33.9
	(IH 54-60	from skull 20-22	14-16	31-38)
intermedia (9)	54-56 av. 54.5	16-19 av. 17.1	15-16 av. 15.9	32-37 av. 34
	(IH 53-59	from skull 19-22	—	34-40)
Females				
brevirostris (1)	52	14.5	16	31
asiatica (23)	51-56 av. 52.8	13.5-18.7 av. 16.2	13-16 av. 14.6	28-32 av. 30.2
	(IH 51-56	from skull 20-22	14-15	29-34)
intermedia (4)	49, 50, 52, 55	17, 17.5 (3)	15, 16 (3)	28, 30 (2), 35
	IIH 50-55	from skull 19-20	—	30-35)
1919-1921. *Aethopyga gouldiae* subspp.				
Males				
gouldiae (9)	55-59 av. 57	14-16.5 av. 14.7	15-16.5 av. 15.4	64-78 av. 72.1
	(IH 52-58	from skull 20-25	15-18	60-86)
dabryii (1)	55	—	—	65
	(IH 53-59	—	—	75-76
Females				
gouldiae (3)	50, 51(2)	13, 14, 16.5	14.2, 15, 15.5	30, 36, 46
	(IH 48-52	from skull 20-22	14-15	35-47)
1922-24. *Aethopyga nipalensis* subspp.				
Males				
horsfieldi (2)	54, 55	18.2, -	16, 16.5	62, -
	(IH measurements as in *nipalensis*)			
nipalensis (3)	52, 54 (2)	18.5, 20.5, -	16 (3)	60, 63, -
	(IH 51-58	from skull 20-23	*c.* 15	58-70)
koelzi (10)	53-56 av. 54.8	19.5-21 av. 20	15-15.5 av. 15.1	57-68 av. 62.5
	(IH 53-57	from skull 25-26	*c.* 15	58-64)
Females				
koelzi (8)	49-54 av. 51.6	18-20 av. 19	15-16 av. 15.1	41-43 av. 42
	(IH 50-52	from skull 22	*c.* 15	41-46)

	Wing	Bill	Tarsus	Tail
		1925-26. *Aethopyga saturata* subspp.		
Males				
saturata (10)	52-57 av. 54.8	16.5-20 av. 18.7	15-16 av. 15.4	65-78 av. 72
	(IH 53-58	from skull 20-25	14-17	63-81)
assamensis (7)	51-55 av. 53.5	16-20.5 av. 18.3	14.5-15 av. 14.9	61-73 av. 69.4
	(IH 51-55	from skull 20-21	*c.* 15	69-79)
Females				
saturata (2)	48, 50	17.7, 18.8	14 (2)	36, 37
	(IH 47-49	from skull 20-22	14	32-37)
assamensis (5)	44-48 av. 46.2	15.5-18 av. 16.8	13-15 av. 14	25-33 av. 29.6
	(IH 44-48	from skull 18-19	—	—)
		1927-1929 a. *Aethopyga siparaja* subspp. & EL.		
Males				
seheriae (26)	54-63 av. 57.3	15.5-19.5 av. 18	14-16 av. 14.7	58-75 av. 65.7
	(IH 53-60	from skull 20-23	14-16	62--76)
labecula (5)	52-58 av. 54.8	16.5-19 av. 17.6	14.5-16.5 av. 15.6	58-68 av. 64
	(IH measurements as in *seheriae*)			
vogorsii (8)	60-63 av. 61.5	18-21 av. 19.5	15-16 av. 15.5	52-56 av. 53.3
	(IH 61-65	from skull 23-27	15-16	50-58)
nicobarica (5)	49-52 av. 50.8	17.5-19.6 av. 18.3	14-15 av.14.4	35-45 av. 39.6
	(IH 50-52	6-	—	40-45)
El. *cara* Baker	53-57	14-15	14-15	40-48)
Females				
seheriae (6)	50-54 av. 51.6	17-18.5 av. 17.75	14-16 av. 14.5	33-39 av. 36.5
	(IH 47-53	from skull 19-21	14-16	34-39)
labecula (5)	48-51 av. 49.4	17-19.8 av. 18.33	15-15.5 av. 15.1	28-35 av. 32.2
vigorsii (2)	52, 54	17, 18.5	15 (2)	35 (2)
	(IH 54-57	from skull 21-24	15-16	35-38)
nicobarica (1)	45	17.5	14	32
	(IH —	—	—	32-33)
		1930. *Aethopyga ignicauda* subspp. & EL.		
Males				
ignicauda (9)	57-62 av. .59	17-21 av. 18.9	16-17 av. 16.6	43-52 av. 48.5
	(IH 55-60	from skull 21-24	*c.* 16	*c.* 48)
Females				
ignicauda (2)	51, 52	18, 18.5	16 (2)	38, 39
	(IH 52-56	from skull 21-22	*c.* 16	*c.* 40)
El. *flaviscens* (1)	55	19.2	17	95
		1931. *Arachnothera longirostris longirostris*		
Males (11)	60-66 av. 63.7	32-35 av. 33.2	15-16.5 av. 15.3	36-42 av. 39.6
	(IH 64-67	from skull 34-37	c. 15	40-42)
Females (5)	59-63 av. 60.6	30.5-35 av. 31.7	15-16.5 av. 15.3	32-39 av. 35.6
	(IH 59-60	from skull 32-33	*c.* 15	36-38)
		1932. *Archnothera magna magna*		
Males (14)	81-93 av. 88.2	35.5-42 av. 39	20-22 av. 20.8	41-49 av. 44.4
	(IH 84-96	from skull 45-47	20-21	44-52)
Females (5)	78-87 av. 82.2	36-37 av. 36.8	20-22 av. 21	39-44 av. 40.8
	(IH 78-84	from skull 42-44	20-22	39-48)

	Wing	Bill	Tarsus	Tail
1933-36. *Zosterops palpebrosa* subspp.				
Males				
palpebrosa (39)	50-61 av. 54	9-11 av. 9.7	15-16 av. 15.4	31-41 av. 37.1
	(IH 50-57	from skull 11-14	15-16	34-41)
salimalii (13)	51-57 av. 54	9-10.3 av. 9.6	15-16 av. 15.7	38-41 av. 39.2
	(IH 53-57	from skull 11-12	14-16	37-40)
nilgiriensis (3)	53-56 av. 55	10-11 av. 10.5	15-16 av. 15.5	38-40 av. 39.1
	(IH 54-58	from skull 13-14	15-17	34-42)
nicobarica (5)	50-55 av. 52.8	10-12 av. 11.2	15-16 av. 15.7	30-37 av. 33.8
	(IH 54-56	from skull 13-14	15-16	34-36)
Females				
palpebrosa (19)	51-57 av. 53	9-10.5 av. 9.6	15-16 av. 15.4	33-40 av. 36.6
	(IH 50-55	from skull 11-14	15-16	35-36)
salimalii (7)	51-55 av. 53.3	9-10 av. 9.4	14-16 av. 15	32-40 av. 36.6
	(IH 51-55	from skull 11-12	14-16	35-39)
nilgiriensis (3)	53, 55, 56	10, 10.5, 11	15.5, 15.5, 16	39, 40, 41
	(IH 53-57	from skull 13-15	15-17	36-41)
nicobarica (4)	52, 54, 54, 55	11, 11, 11.2, 11.5	15.5, 15.5, 16, 16	34,35, 38, 40
	(IH 52-56	from skull 13-14	—	32-35)
1937. *Zosterops ceylonensis*				
Female (1)	57	12	16	40
	(IH 55-57	from skull 15-16	16-19	38-41)

(*To be continued*)

SOME ASPECTS OF THE REPRODUCTIVE BIOLOGY OF *ONTHOPHAGUS GAZELLA* (F.) AND *ONTHOPHAGUS RECTECORNUTUS* LANSB. (COLEOPTERA: SCARABAEIDAE)[1]

K. Veenakumari[2] and G.K. Veeresh[3]

(*With a plate*)

Key words: *Onthophagus gazella, Onthophagus rectecornutus,* biology, nesting

Reproductive biology of *O.gazella* was studied in the laboratory. The duration and size of different developmental stages were recorded. On the average the development from egg to adult took 41.3 days. Hatching of an egg of *O. gazella* and larval emergence were observed under a stereo microscope. Mites belonging to *Caloglyphus karnatakensis* were found feeding on the eggs of *O.gazella* and the fungi *Beauveria* sp. and *Metarhizium* sp. infected their pupal stage. *O.rectecornutus* took 31.8 days to complete its life cycle.

Introduction

Various species of *Onthophagus* have been extensively studied (Fabre 1897, Main 1922, Sim 1930, Lindquist 1933, Ritcher 1945, Halffter and Mathews 1966, Tyndale-Biscoe *et al.* 1981, Fincher and Hunter 1987, to cite a few). Halffter and Edmonds (1982) have defined seven nesting patterns of dung beetles. Onthophagini fall under pattern I. Pattern I is characterized by the following characters: a) very high fecundity, b) larval food in the form of a brood mass, c) construction of pupal chamber by the larva within the brood mass. Rougon and Rougon (1980) reported that *O.gazella* took 41 days to complete its life cycle. Lee and Peng (1982) worked on the nesting density and progeny size of *O.gazella. O.gazella* has been introduced to Australia (Lee 1979) and to Solomon islands (Stapley 1979) for the biological control of bush flies. As *Onthophagus* is the largest genus in the entire animal kingdom (Matthews 1976) many of the species have been poorly studied. In this connection an attempt was made to study the reproductive biology of the two commonly occurring South Indian species — *O.gazella* and *O. rectecornutus.*

Material and Methods

This study was conducted in Hebbal, which is on the outskirts of Bangalore, Karnataka. The mean minimum temperature, mean maximum temperature and total annual rainfall were 18.2°C, 29.8°C and 548.3 mm, respectively.

Adults of *O.gazella* and *O.rectecornutus* were collected from cow dung pats and also from the soil beneath dung pats in pastures. *O.rectecornutus* were found in large numbers in shaded dung pats.

Glass jars (33.5 cm x 10.5 cm) were filled with moist soil and freshly deposited cow dung was dropped on the soil. Five pairs of beetles of either sex of the same species were released in the jars. The top of the jar was covered with a wire gauze and the jars were kept in the dark. After about 5-8 days the soil from the jar was removed carefully and the brood of each species was maintained in plastic boxes with moistened soil. Duration and size of different developmental stages were recorded. Observations were also made on nest construction and mating of *O. rectecornutus* in the glass jars. Observations were made on the nature of emergence of the larva of *O.gazella* from the egg using a stereo microscope.

Results

Adults of *O.gazella* emerged after the first showers in May. They were found from May to

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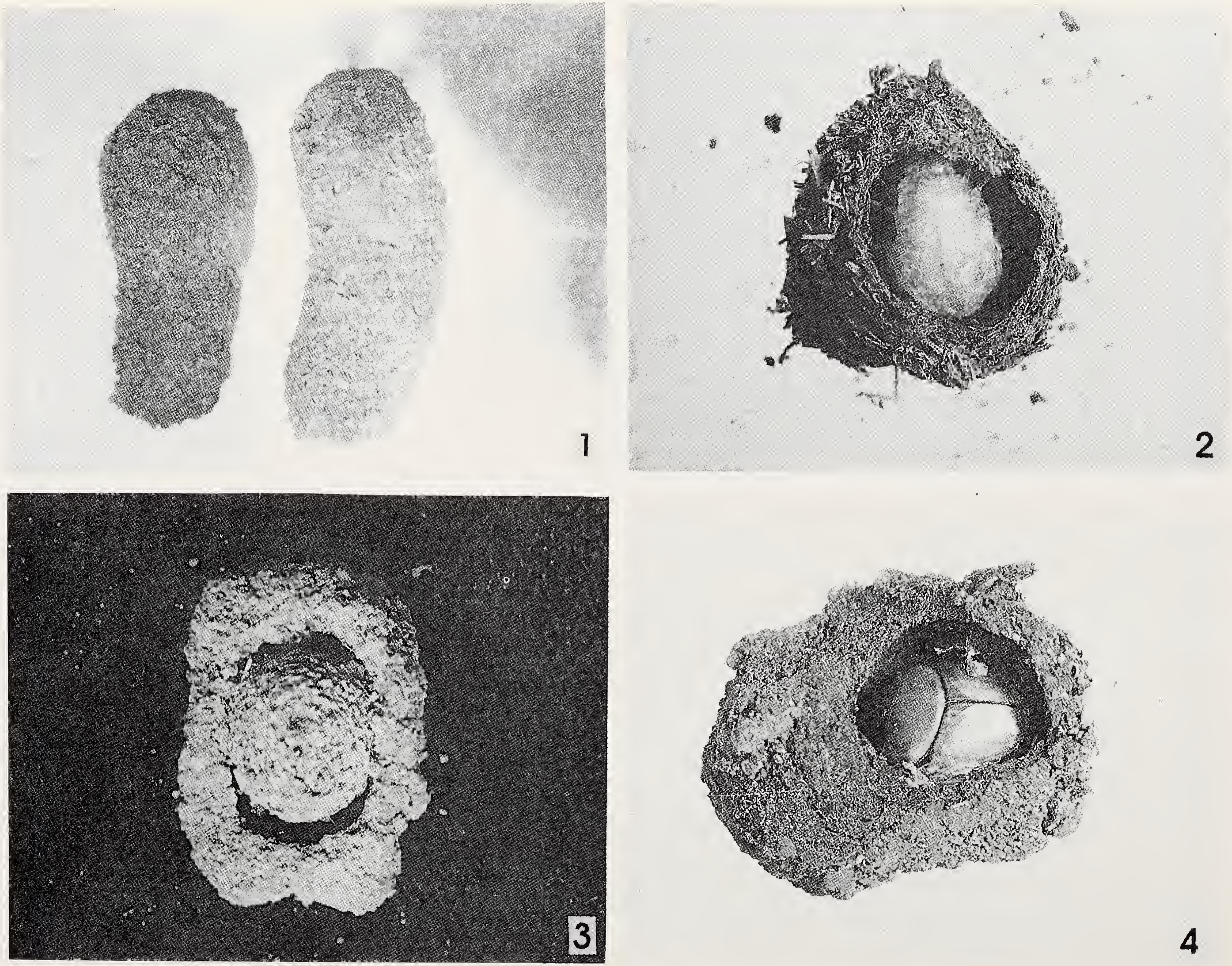

Fig. 1. Cylindrical brood masses of *Onthophagus gazella* (F.); Fig. 2. Intial stages of cocoon construction by *O.gazella* (F.): Fig. 3. Cocoon of *O. gazella* (F.) in brood mass; Fig. 4. Newly formed adult of *O. gazella* (F.) in the cell.

February with peak population in May.

Feeding: Adult beetles were found feeding either in dung or in shallow vertical tunnels beneath the dung. They dug tunnels underneath the dung and filled the tunnels by bringing dung little by little from the surface. These food burrows were made 5-6 cm deep. In this fashion the males and the females fed separately in their individual food burrows for 8-10 days.

Brood burrows: After the completion of the feeding period males and females were found together in much deeper burrows (16.5 ± 3.0 cm, n = 8). A broad ended burrow was constructed and the female provisioned it with dung. Sometimes the male helped her. After filling 3/4 of the broad ended tunnel she laid an egg in it and closed the egg chamber with a layer of dung. Following the construction of one brood mass she excavated a neighbouring cavity in which she fashioned a second brood mass. The brood masses were cylindrical in shape. The average length, width and weight of brood masses are 40.6 ± 0.03 mm, 16.0 ± 0.08 mm, 8.4 ± 0.9 g (n = 15), respectively (Plate 1, Fig. 1).

Egg: The egg was laid in the egg chamber which stood in a vertical position. The inner side of the egg chamber was smeared with the excreta of the female. The eggs were elongate, cylindrical and creamy white. Later on the egg increased in size and became spheroidal in shape. Those eggs which were lying on their sides became black and never hatched. On an average a female laid 6 eggs in one nest in the laboratory. The measurements of the eggs are given in Table 1.

Hatching: Close to hatching, the egg shell became transparent and the 'V' shaped larva was clearly visible through the chorion. The larva emerged with its abdominal end first. It contracted and expanded its body several times. After some time the head also emerged. The larva withdrew its abdominal end many times and stretched its body and touched the distal end of the abdomen with the head and shrank back. This was repeated many times till it completely freed itself from the shell.

TABLE 1
DIMENSIONS OF DIFFERENT LIFE STAGES OF
O. gazella AND *O. rectecornutus* IN mm

O. gazella

		N	Min.	Max.	Average	S.D.
Egg stage I	L	8	2.5	3.5	3.1	0.2
	B	18	1.0	1.5	1.4	0.1
Egg stage II	L	7	3.0	4.0	3.3	0.3
	B	7	2.5	2.0	2.07	0.1
Larva I instar		25	9.0	15.0	11.4	1.7
Larva II instar		25	15.0	20.5	18.5	1.3
Larva III instar		18	17.0	24.0	20.1	1.5
Pupa	L	22	9.4	13.0	11.2	0.8
	B	22	6.0	8.5	7.4	0.7
Cocoon	L	29	13.0	18.0	16.1	1.2
	B	29	10.0	12.5	11.2	0.7

O. rectecornutus

		N	Min.	Max.	Average	S.D.
Egg stage I	L	15	2.7	2.8	2.75	0.1
	B	15	0.9	1.2	1.1	0.09
Egg stage II	L	16	2.8	3.3	3.0	0.12
	B	16	1.6	1.9	1.7	0.09
Larva I instar		25	9.0	12.0	10.9	0.9
Larva II instar		25	14.5	17.5	16.1	0.8
Larva III instar		25	17.5	25.0	20.4	1.9
Pupa	L	26	9.0	11.5	10.2	0.6
	B	26	5.5	7.0	6.3	0.3
Cocoon	L	11	11.0	14.0	11.6	0.9
	B	11	9.5	11.0	9.70	0.6

L= Length; B = Breadth

The newly emerged larva was transparent, with only the tips of the mandibles being dark brown. All the legs on each side appeared to be attached to each other distally.

Larva: The larva had its characteristic hump which it used as a pivot when it fed on the dung in the brood mass. For the first few days the hump remained transparent.

These larvae once taken out of their brood masses were seen moving on the lateral sides of their abdomen and never used their legs. They excreted a greyish brown semi-solid paste. Using this material they repaired any damage to the brood mass. From the second instar onwards the larva started biting with its mandible once disturbed. The measurements of different larval instars are given in Table 1.

Whenever a larva was placed in an artificially fashioned dung ball with a cavity bigger than what the larva required, the volume of the cavity was reduced so that it fitted against the larval body. It did this by pulling and remaking the inner wall of the brood mass with its mandibles.

Cocoon construction: Towards the end of the third instar the larva started constructing a cocoon or pupal cell. A greyish brown paste was excreted from the abdominal end and held on the truncated end of the abdomen till it dried partially (Plate 1, Fig. 2). The larva constructed the cocoon till 3/4th of it is finished and then used its mouth parts to extend the paste and spread it across the opening. During this process the construction collapsed many times. Inspite of this, the larva worked continuously till the whole cocoon was completed. The inner surface of the cocoon was very smooth and the outer surface coarse. These cocoons could be easily separated from the brood mass. The upper 1/3 of the cocoon easily came off as a cap when a little pressure was applied on that region (Plate 1, Fig. 3).

TABLE 2

NUMBER OF DAYS TAKEN TO COMPLETE EACH LIFE STAGE OF *O. gazella* AND *O. rectecornutus*

O.gazella

	N	Min.	Max.	Average	S.D.
Egg	5	5	6	5.4	0.54
Larva	5	25	28	26.2	1.22
Pupa	6	10	12	11.16	0.98
Total life cycle	5	40	44	41.4	2.60

O. rectecornutus

	N	Min.	Max.	Average	S.D.
Egg	10	3.0	5.0	4.0	0.47
Larva	5	17.0	21.0	19.0	2.00
Pupa	9	9.0	12.0	10.88	1.05
Total life cycle	10	30.0	35.0	31.8	1.93

By the time the larva finished constructing the cocoon, it had become creamy white, and its alimentary canal was entirely empty.

The larva then attained the prepupal stage and did not feed further. The larva had considerably shrunk in size and showed very little movement even when disturbed. The cocoon length and breadth are given in Table 1.

Pupa: The newly formed pupae were creamy white, shiny, with five pairs of finger-like processes on the dorso-lateral region of the abdomen. Later on, the pupae turned golden brown in colour with the tips of fore tibiae and clypeus being dark brown. Sexual dimorphism was evident in pupae. The male pupae had two horns on the head along with a median projection, whereas the female had only the median projection. The average length and breadth of the pupae are shown in Table 1.

Adults: Once the adults emerged they stayed in the cocoon for about 3-4 days (Plate 1, Fig. 4). They made their way out by boring a hole in the brood mass and entered the soil. Adults took 3-4 days to develop pigmentation. The last three abdominal segments were left exposed in a newly formed adult. The durations of different developmental stages are presented in Table 2.

Natural enemies of *O. gazella*: 75 pupae were affected by the white muscardine disease (*Beauveria* sp.). Some of the newly formed adults also had the fungus appearing white and fluffy all over their bodies. Twelve pupae were affected by green muscardine disease (*Metarhizium* sp.). In both the cases the pupae were immobile. In addition mites belonging to *Caloglyphus karnatakensis* (Acari: Acaridida: Acaraidae) were found feeding on the eggs.

Biology of *O.rectecornutus*: Biology of *O.rectecornutus* resembled *O.gazella* in many respects. However there were some differences like the number of days taken for development of each life stage, the number of eggs laid by the female, etc.

Adults of *O.rectecornutus* were found throughout the year with a peak population during the month of December.

Feeding: Adult beetles fed in shallow food burrows which measured 4-5 cm. These food burrows were inhabited by both sexes separately. They fed in these food burrows for a week and then started making brood burrows.

Brood burrows: The brood burrows were long (12 ± 2 cm, n=7) with a broad brood chamber at the base. The females constructed the brood chamber either alone or in cooperation with a male. A detailed description of a pair constructing a nest and mating is given below.

A vertical tunnel was constructed below the dung pat and both the male and female were seen moving in the tunnel. The male carried dung from the top and deposited it midway. The interaction between the male and the female was observed only once when the male met the female who was coming up the tunnel. Initially, he appeared to behave aggressively by butting her with his clypeus. Then he pushed the female and stood above her and copulated with her, supporting himself by leaning on the walls of the tunnel (soil and glass wall) with his front legs. During mating the female exhibited some backward jerking movements. They mated for 2 minutes and 30 seconds.

The male collected the dung with his forelegs and moved down the tunnel and deposited it midway down the tunnel. The female went upwards and collected the dung with her forelegs and moved down the tunnel with her rear end first. She brought it to the broad end of the chamber and packed it against the wall of the chamber. When the male did not bring a sufficient quantity of dung the female virtually scraped the place and collected whatever dung was sticking against the walls of the burrow and brought it down the chamber. Sometimes she was also seen dropping dung down the tunnel without carrying it. When the male did not return she herself went and brought the dung. Now and then the male and female met each other but they behaved calmly without exhibiting any hostility towards each other.

The brood masses are cylindrical in shape. The number of brood masses varied between 10 and 15, the average being 12 brood masses per nest (12 ± 2.5, n = 5). The average length and breadth of the brood masses was 34.7 ± 0.33 mm, and 11.3 ± 0.11 mm (n=15), respecively.

Egg: The egg was cylindrical and creamy white in colour and resembled that of *O. gazella* but for the size. The measurements are given in Table 1.

Larva: The larva resembled that of *O.gazella* in all instars but for the measurement (Table 1). Behaviours such as movement, cocoon construction, repairing the damage of brood mass was similar to that of *O.gazella*. The pupae were also similar to that of *O.gazella*. The measurements of different larval instars and pupae are given in Table 1.

The number of days taken to complete the developmental stages are presented in Table 2.

DISCUSSION

There are two types of nests in Onthophagini. They are simple nests and compound nests (Halffter and Edmonds 1982). Both *O.gazella* and *O.rectecornutus* belong to the latter nesting type as they produce several brood masses in a single nest. *O. gazella* produced 6 brood masses per nest whereas *O. rectecornutus* produced 12 brood masses per nest. Halffter and Edmonds (1982) have reported that *O. gazella* is a prolific breeder and produces about 180-200 brood masses per female. Here the reduction in number of brood masses may be due to the restricted place that was provided for the breeding pair. As the brood masses of *O.rectecornutus* were smaller than those of *O. gazella*, more brood masses were produced. Even though there is no true cooperation between the male and the female as in *Copris* spp. (Halffter and Edmonds 1982), there was some assistance from the male to the female in bringing the dung to make the brood masses.

Rougon and Rougon (1980) studied the biology of *O.gazella* and reported that it needs 41 days to complete its life cycle. In the present study it was found that while *O.gazella* took 41.3 days to complete its life cycle *O. rectecornutus* took a shorter time of about 31.8 days. This is because of the short larval stage of *O.rectecornutus*.

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NEW DESCRIPTIONS

AN INTERESTING NEW SPECIES OF *ANNECKEIDA* BOUCEK (HYMENOPTERA:TORYMIDAE) FROM INDIA[1]

P.M. Sureshan[2] and T.C. Narendran[3]

(*With five text-figures*)

A new species of Torymidae, namely *Anneckeida indica* is described from the Indian sub-continent.

Introduction

The genus *Anneckeida* Boucek was so far unknown in the Indian sub-continent. Boucek (1978) recognised five species, *A. watshami* (Type species) from Rhodesia, *A. angustifrons*, *A. orientalis*, *A. latifrons* and *A. laotica* from the Oriental Region.

Our studies of the torymid fauna (Narendran 1984, 1994; Narendran and Sureshan 1988, 1989) reveal the existence of *Anneckeida* in the semi-evergreen forest patch at Kottiyoor, under the Kannur forest division of Kerala. The recorded species, *A. indica* is recognised as new and hence described. This forms the first record of the genus from the Indian sub-continent.

The type specimens are presently kept in the collections of Zoological Survey of India, Western Ghats Field Research Station, Calicut but eventually will be deposited in the National Zoological collections of Zoological Survey of India, Calcutta.

Anneckeida indica sp. nov.
(Figs.1-5)

FEMALE: Length 2.0 mm. Body black, with T1 metallic bluish violet, mainly on dorsal side; eyes dark cupreous; ocelli pale yellow. Antennae testaceous, with club slightly darker. All coxae and hind femora concolorous with body; fore and mid femora and all tibiae dark brown; tarsi testaceous, with tips dark brown. Tegulae dark brown; wings hyaline with pubescence and veins pale brown.

Head (Figs. 1, 3 & 4) uniformly microreticulate, with dense pubescence. In dorsal view head width nearly 2x length (25:13); temples strongly receding, length nearly 0.5x eye length; POL: OOL =8:1; maximum diameter of ocellus 4. In front view head width 1.3x height (29:23); width of fronto-vertex at median ocellus 0.31x head width (9:29); malar space length 0.38x eye length; inner orbits converging upwards; ocelli in acute angular triangle, lateral ones nearly touching the eyes; anterior part of clypeus slightly convex, smooth, anterior margin rounded.

Antennae (Fig.2) short, formula 1183; scape length 0.38x eye length (12:31); pedicellus plus flagellum nearly half of head width (19:37).

Thorax: Dorsum of thorax with dense squamose reticulate sculpture and dense pubescence; collar nearly as broad as mesoscutum, anterior edge rounded, lateral panel depressed. Mesoscutum width 2.3x length, with notauli complete, shallow. Scutellum almost as long as broad, anterior margin separated by a deep groove; smooth frenal area taking up one third length. Propodeum shiny, width 4.1x median length, with large reniform spiracles; median carina strong, intersecting broad triangular foveolate depression; callus densely hairy. Mesepimeron smooth and shiny, with a crenulate vertical furrow in the middle. Mesepisternum moderately reticulate, slightly depressed posteriorly and delimited anteriorly by a sharp edge. Prepectus small, shiny. Metapleuron densely hairy, slightly

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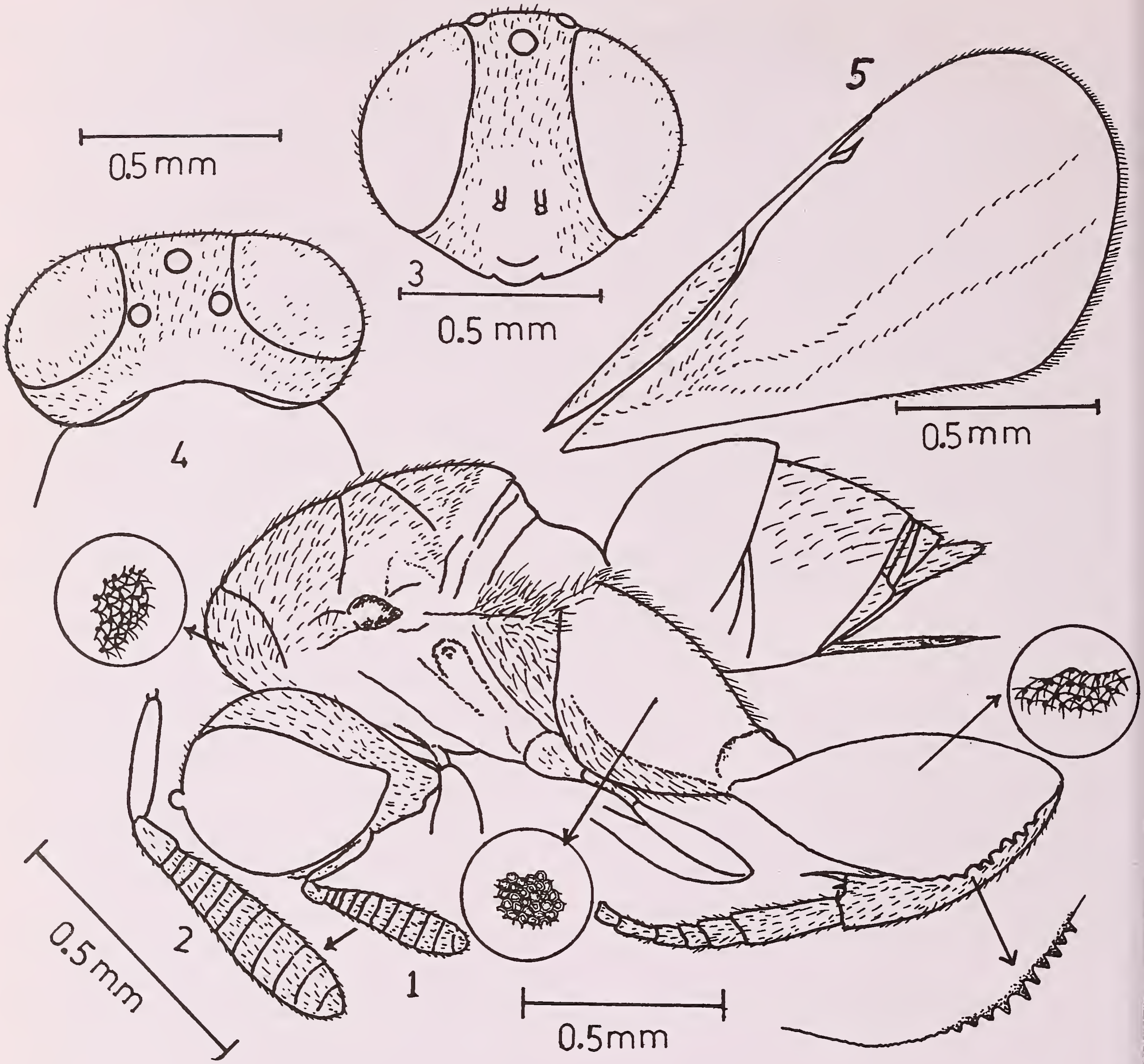

Figs. 1-5. *Anneckeida indica* sp. nov. Female: 1. Body in profile; 2. Antenna; 3. Head in front view; 4. Head in dorsal view; 5. Forewing.

depressed and reticulate. Fore and mid legs normal. Hind coxae (Fig. 1) large, lateral face flat and bare with moderately raised reticulation; dorsal and ventral edge hairy. Hind femur very large, length 1.4x width, reticulate, ventral edge with a comb of teeth, these minute up to middle, larger and wider towards tip, length of long spur about 0.7x the breadth of tibial apex. Hind tarsus length equal to hind tibia. Forewing (Fig. 5) densely pubescent, length 2x width. Relative lengths of smv, mv, pmv, and stv as 24, 11.5, 5.5 and 2.

Gaster (Fig. 1) sessile, convex, length 1.8x width in dorsal view and length 1.2x that of hind femur in profile; T1 large and bare; T2 and T3 visible only laterally; T4 large and hairy, apical edge bare; ovipositor sheath and ovipositor strongly protruded.

MALE: Length 1.8-1.9 mm. Similar to female, but body slightly shorter with bluish violet gloss on T1 less prominent and apex of gaster slightly different.

Holotype: FEMALE: INDIA: Kerala: Kottiyoor R.F (Kannur), Ambayathodu, 2.ii.1995, Coll. P.M Sureshan.

Allotype: MALE: Same data as that of holotype.

Paratype: 1 Male, data same as that of holotype.

Remarks: This species differs from all Oriental species in the absence of a conspicuous large tooth at the beginning of comb of teeth on hind femora. However, it resembles the Oriental species *A. angustifrons* in having inner orbits of head distinctly converging upwards, narrow frons and ocelli in acute angular triangle with lateral ones virtually touching the eyes. But it differs from *angustifrons* in having comparatively wider frontovertex (0.31x head breadth), scutellum with smooth frenal area taking up one third length, length of long spur of hind tibia about 0.7x the breadth of tibial apex, tip of T4 only bare and apex of T1 and base of T4 not being in the same plane and in its smaller size (2.0 mm). (In *angustifrons* frontovertex is 0.25x head breadth, smooth frenal area of scutellum taking up only a quarter of the length, length of long spur of hind tibia about 1.1x breadth of tibial apex, apical third of T4 bare, apex of T1 and base of T4 almost in the same plane and size larger 2.5 mm).

Following Boucek (1978), the species comes close to *A. watshami*, but differs from *A. watshami* in having frontovertex narrow with inner orbits distinctly converging; inner margins of eyes distinctly diverging mouthwards; antenna with first flagellar segment slightly shorter than second, pedicellus not ovoid, longer than three following segments combined; clypeus almost rounded anteriorly; hind coxa on bare part with reticulation not umbilicate, hind femur with teeth wider apart and length 2.0 mm. (in *watshami* frontovertex not much narrower with inner orbits not distinctly converging; inner margins of eyes only slightly diverging mouthwards; first flagellar segment slightly longer than second, pedicellus ovoid, about as long as three following segments combined; clypeus sub-truncate anteriorly; hind coxa on bare part with umbilicate punctures and hind femur with teeth closer and length 2.1-2.4 mm).

ACKNOWLEDGEMENTS

P.M.S. is grateful to the Director, Zoological Survey of India, Calcutta and the Officer-in-charge, Zoological Survey of India, Western Ghats Field Research Station, Calicut for providing facilities and encouragement. We are thankful to the authorities of University of Calicut, Kerala for the facilities provided.

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TWO NEW SPECIES AND A REVISED KEY TO GENUS *NEODIPLOCONUS* HYSLOP (COLEOPTERA, ELATERIDAE: MELANOTINAE) FROM INDIA[1]

PUNAM AND V. VASU[2]

(*With eleven text-figures*)

To the previously recorded four species of genus *Neodiploconus* Candeze from India, two new species have been added. The new species described and illustrated are *N. dirangensis* and *N. neeraae*. A key for identification of all Indian species of this genus is provided.

INTRODUCTION

Candeze (1860) erected the genus *Diploconus* based on eleven species. Because this name was preoccupied, Hyslop (1921) renamed it as *Neodiploconus* which was treated by Schenkling (1927) in the *Coleopterorum catalogus* as such. So far only four species of this genus were known from the Indian subcontinent, and all have been described under the genus *Diploconus* Candeze, i.e. three species by Candeze (1860, 1891, 1896) and one by Fleutiaux (1902). In the present paper two new species have been described and illustrated providing complete distributional data and population variation (if any). A dichotomous key for the Indian species is given. Holotypes of new species will be deposited at the Indian Agricultural Research Institute, Pusa National Collections, Division of Entomology, New Delhi.

KEY TO INDIAN SPECIES OF *Neodiploconus* HYSLOP

1. Body unicoloured; pronotum with median tubercle at its posterior border. 2
— Body bicoloured; pronotum simple 3
2. Legs black; pronotal punctation very fine .... *nigerrimus* (Fleutiaux, 1902)
— Legs ferruginous; pronotal punctation very large .... *coracinus* (Candeze, 1860)
3. Elytra black; pronotum mainly red 4
— Elytra red with brownish margins; pronotum black .... *ornatus* (Candeze, 1891)
4. Elytra truncate at extremity; pronotum with one small, black median spot .... *brevis* (Candeze, 1896)
— Elytra rounded at extremity; pronotum with three median spots 5
5. Pronotum with small, median, almost rounded spot one each on lateral sides, confluent with broad median spot covering most of dorsal surface (Figs. 1,2); antenna extending beyond posterior angle of prothorax, segment 3 longer than 2 as 3:2; posterior angle with a tuft of setae .... *dirangensis* sp.nov.
— Pronotum with small, median, almost rounded spots one each on lateral sides and another on dorsal surface (Fig. 3); antenna not reaching posterior angle of prothorax, segment 3 equal to 2; posterior angle without a tuft of setae .... *neeraae* sp. nov.

Neodiploconus dirangensis sp. nov.
(Figs. 1, 2, 4, 6, 7, 9, 11)

Description.:*Colour*: Body black, alizarine are: lateral one fourth of pronotum except median, almost rounded spot and pronotal angles (Figs. 1, 2); propleurae entire; all sternites entire. Antenna black. Legs piceous.

Measurements: *Body*: Length 9.5 mm, width 1.75 mm; head: length 0.75 mm, width 1.25 mm; antenna 3.5 mm; thorax: length 2 mm, width 1.75 mm; elytra 6.5 mm.

Structure: Body width less than 0.25 x its length. Head flat, broader than long as 5:3; frons with anterior margin rounded, supra-antennary crest transverse (Fig. 9). Antenna serrate (Fig. 7), extending beyond posterior angle of prothorax; segment 3 longer than 2 as 3:2 but distinctly shorter than 4 as 4:9. Pronotum subconvex with faint medial longitudinal depression in its posterior 1/3, longer than broad as 8:7, gradually narrowing anteriorly, bicarinate, carinae short, not reaching middle of prothorax; posterior angles rounded, with a tuft of

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setae (Fig. 1). Prosternal spine pointed, not margined, gradually narrowing at base, inclined at 30° from its main axis. Scutellum flat, longer than broad as 5:3, anterior and posterior margins rounded, lateral sides constricted anteriorly (Fig. 4). Elytra flat, 3.25x prothorax length, rounded at extremity (Fig. 11); striae distinct. Metabasitarsus equal to following 2 joints combined.

Sculpture: Head with simple, dense, moderate, rounded punctation; pronotum with simple, sparse, small, rounded punctation; propleurae punctated like pronotum; prosternum with simple, sparse, small, rounded punctation; elytral striae with deep, distinct, rounded punctation; interstriae with shallow, scattered punctation.

Pubescence: Body covered with simple, dense, erect, blackish pubescence.

Male genitalia: Fig. 6. Phallobase with two anterolateral processes, anterior margin arcuate. Parameres simple, with subapical processes. Aedeagus longer than parameres, tubular and ending into nipple-like apex: furcae long, extending well beyond anterior limits of parameres.

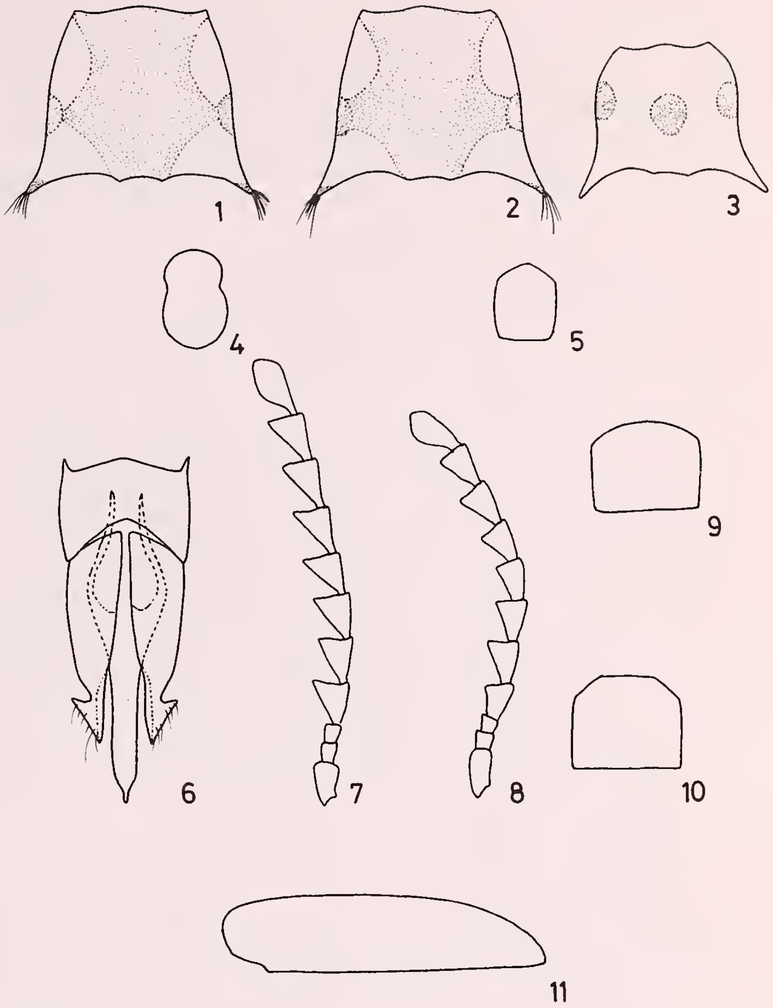
Material examined. *Holotype*: Male, Arunachal Pradesh, Dirang, 1500 m, 10.5.1992. *Paratypes*: 3 males, 1 female, with same data as holotype.

Distribution. INDIA: Arunachal Pradesh.

Population variation: Lateral medial black spot may be narrowly to broadly confluent with broad medial black spot (Fig. 2).

Diagnostic characters: On the basis of some broad key characters such as: bicoloured body; black elytra with rounded extremities and bicoloured, simple pronotum, *N. dirangensis* remains distinctly separated from all the Indian species of this genus but comes close to *N. neeraae* from which it differs in pronotum having large blackish dorsal surface (small spot in latter), antenna extending beyond posterior angle of prothorax (not reaching posterior angle in latter), segment 3 longer than 2 (equal in latter) and posterior angle with a tuft of setae (without setae in latter).

Etymology: Species name pertains to its type locality.



Figs. 1-3. Pronotum: 1. *Neodiploconus dirangensis,* 2. *N. dirangensis* (Population variation), 3. *N. neeraae;* Figs. 4-5. Scutellum: 4. N. *dirangensis,* 5. *N. neeraae;* Fig. 6. Male genitalia of *N. dirangensis*; Figs. 7-8. Antenna: 7. *N. dirangensis,* 8. *N. neeraae*; Figs. 9-10. Head: 9. *N. dirangensis,* 10. *N. neeraae*; Fig. 11. Elytra of *N. dirangensis.*

Neodiploconus neeraae sp. nov.
(Figs. 3,5,8,10)

Description: *Colour*: Body black, alizarine are: pronotum (Fig. 3) except three small, medial spots (one each on lateral side and one on dorsal surface); propleurae; mesosternum; mesosternal plate; and all sternites except posterior half of apical one. Antenna black. Legs piceous.

Measurements: *Body*: Length 10.5 mm, width 2.5 mm; *head* length 0.75 mm, width 1 mm; *antenna* 3 mm; *thorax* length 2.25 mm, width 2.5 mm; *elytra* 7 mm.

Structure: Body width less than 0.25 x its length. Head flat, broader than long as 4:3; frons with complete carina, anterior margin truncate, supra-antennary crest oblique (Fig. 10). Antenna subserrate (Fig. 8), not reaching posterior angle of prothorax; segment 3 equal to 2 but distinctly shorter than 4 as 2:3. Pronotum convex with a distinct median longitudinal furrow in its posterior 1/3, broader than long as 9:8, gradually narrowing anteriorly, bicarinate, carinae short, not reaching middle of prothorax; posterior angles rounded, diverging, without tuft of setae; prosternal spine pointed, not margined, gradually narrowing between mesocoxae, descending at 30° from its main axis. Scutellum flat, longer than broad as 5:3, anterior margin arcuate, posterior margin truncate, lateral sides straight and parallel (Fig. 5). Elytra flat, 3.1 x prothorax length, rounded at extremity; striae distinct. Metabasitarsus equal to following 2 joints combined.

Sculpture: Head with simple, dense, moderate, rounded punctation; pronotum with simple, sparse, minute, rounded punctation; propleurae and prosternum punctated like pronotum; elytral striae with deep, distinct, rounded punctation, interstriae with shallow, scattered fine punctation.

Pubescence: Body covered with simple, moderate, erect, blackish pubescence.

MALE: Not found.

Material examined: *Holotype*: Female, Uttar Pradesh, Fata (Sonprayag), 2000 m, 13.6.1994.

Population variation: Single specimen examined.

Distribution: INDIA: Uttar Pradesh.

Diagonostic characters: The characters differentiating *N. neeraae* from *N. dirangensis* have already been indicated elsewhere in this paper.

Etymology: Species name is after its collector, Dr. Neera Raghav.

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A NEW SPECIES OF *DILOPHILA* THOMS. (BRASSICACEAE) FROM GARHWAL HIMALAYA (INDIA)[1]

D.S. RAWAT, L.R. DANGWAL AND R.D. GAUR[2]

(*With a text-figure*)

During recent plant explorations near the snow-line in the alpine zones of Garhwal Himalaya (Northwest Himalaya), a few specimens of Brassicaceae were collected from Roopkund area (4850 m a.s.l.). After checking the literature these were identified as of a new species of the genus *Dilophila* Thom. which is named after Prof. V. Puri.

Dilophila purii sp. nov.

(Fig. 1 A-M)

Herbae parvae perennes, acaulescentes, cum caudice longo. Caudex supra ramosis, unusquisque ramus rosulam foliorum terminalem ferens. Folia spathulata, longe petiolata, 6.0-12.0 x 2.0-4.0 mm, succulentia. Scapus uniflorus, menifeste oriens e

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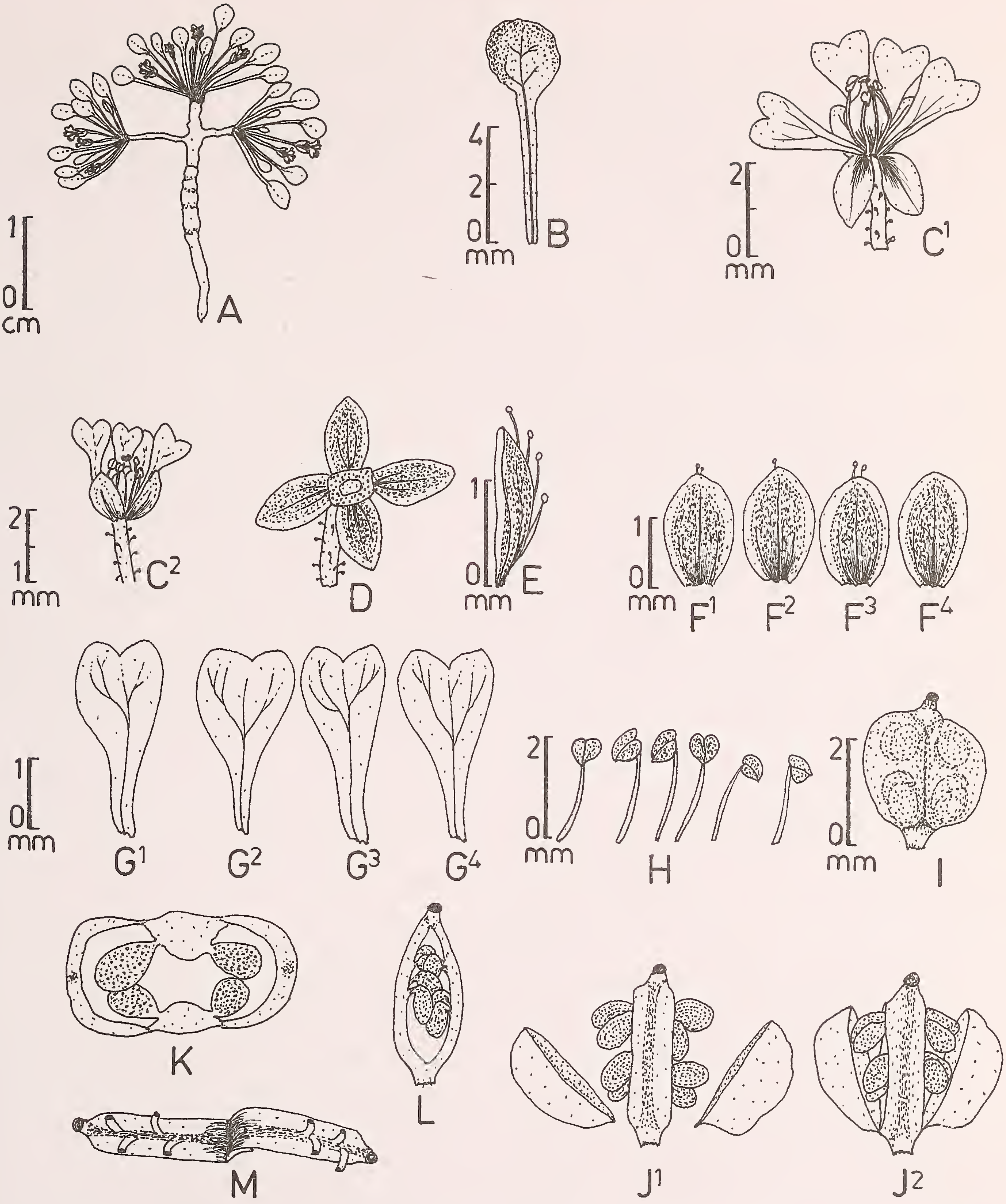
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Fig. 1. A-M. *Dilophila purii* sp. nov.: A. Flowering plant; B. Leaf; C-^{1} C^2. Flowers; D. Sepals and nectary ring; E. Sepal (side view); F^1-F^4. Sepals; G^1-G^4. Petals; H. Stamens; I. Gynoecium; J^1- J^2. The way in which gynoecium open up; K. T.S. of Ovary; L. V.S. of Ovary; M. Two placentae separated.

caudice inter rosulam foliorum, 6.0-10.0 mm longus, sparsim glandularis. Sepala 4, ovata, viridia, marginibus alba, papyracea extus glandularia, 1.5-2.0 x 0.75-1.0 mm. Petala 4, alba ad eburnea, ad apicem bifida, obovata, 2.0-3.0 x 1.0-2.0 mm. Glans annularis nectarifera praedita inter petala et stamina.

Stamina 6, lobi antherae ovati, extrinsecus reflexi, flavi. Carpellum late rotundatum compressum, 2.0-2.5 x 1.5-1.75 mm, uniloculare, ovuli affixi in quoque latere in placentatione parietali, pauci (4-8). Carpellum aperiens a valvis; stylus parvus, stigma fusca. (Fructi maturi non visi).

Typus: INDIA, Northwest Himalaya, Roopkund (4850 m), 11th Aug., 1993, *D.S. Rawat*, Holotypus GUH 22,498 A; Isotypus GUH- 22,498 B.

Small acaulescent perennial herbs with long rootstock. Rootstock branched above, each branch carrying a terminal rosette of leaves. Leaves spatulate, long petioled, 6.0-12.0 x 2.0-4.0 mm, succulent. Scapes single flowered, directly arising from the rootstock from the centre of the rosette of leaves, 6.0-10.0 mm long, sparsely glandular. Sepals 4, ovate, green with white papery margins, glandular outside, 1.5-2.0 x 0.75-1.0 mm. Petals 4, creamy white, bifid at the tip, obovate, 2.0-3.0 x 1.0-2.0 mm. Annular nectariferous gland present between petals and stamens. Stamens 6, anther lobes ovate, reflexed outward, yellow. Carpel broadly rounded, compressed, 2.0-2.5 x 1.5-1.75 mm, unilocular, ovules attached on either sides in the parietal placentation, few (4-8). Carpel opening through valves; style small, thick; stigma dark (mature fruits not seen).

Flowering: August.

Habitat: Among the boulders and scree near snow-line.

The species is allied to *Dilophila salsa* Thoms. but differs from it in having only radical leaves (differently shaped radical and cauline leaves in *D. salsa*), radical leaves being spatulate. Flowers in *D. purii* are solitary on slender scapes which arise directly from the rootstock in the centre of leaf rosette while *D. salsa* has a condensed and compact raceme of 10-20 flowers. Furthermore pedicels and sepals (outside) are glandular in *D. purii.*

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A REMARKABLE NEW GENUS OF BRACONIDAE (HYMENOPTERA) FROM INDIA[1]

C.G. Rema and T.C. Narendran[2]

(*With six text-figures*)

A new Braconid genus, namely *Neoclarkinella* gen. nov. of the subfamily Microgastrinae from India is described and its affinities discussed.

INTRODUCTION

In continuation of our studies on Indian Braconidae (Narendran *et al.* 1992,1996; Sumodan and Narendran 1990), we found out that the species described by Sumodan and Narendran (1990) from Nilambur, actually belongs to a remarkable genus new to science and not to the common genus *Apanteles* Foerster as thought by Sumodan and Narendran (1990). This new genus is described hereunder and its affinities are described. The species is also redescribed adding further details for identification based on fresh materials.

Neoclarkinella gen. nov.

Type species: *Apanteles nilamburensis* Sumodan & Narendran

Diagnosis: Scutellum broad and slightly convex. Scutellar lunules large and triangular. Forewing with radius shorter than first intercubitus. Forewing without areolet. Margin of vannal lobe of hindwing nearly flat and with few sparse hairs.

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Propodeum dull with a strong midlongitudinal carina and rather weak transverse carina basally.

T1 about 4x as long as its apex, aciculate and narrowed at apex. Hypopygium large and striated along median line. Ovipositor longer than hind tibia. Ovipositor sheath hairy throughout, 0.6x as long as hind tibia.

Remarks: *Neoclarkinella* closely resembles the genus *Clarkinella* Mason (Mason 1981) in having propodeum with a complete median carina and a transverse basal carina; T1 parallel sided on the basal half, thence strongly tapered to a narrow apex, hypopygium about half as long as abdomen, ovipositor sheath long and hairy throughout. *Neoclarkinella* however differs from *Clarkinella* Mason in having large and triangular scutellar lunules (lunule of scutellum small and arcuate in *Clarkinella*), forewing without areolet (small areolet present in *Clarkinella*), radius shorter than first intercubitus (radius longer than first intercubitus in *Clarkinella*), transverse carina of propodeum not forming a fork on either side of spiracle (transverse carina of propodeum sending a fork on either side of the spiracle in *Clarkinella*), T1 aciculate (T1 mostly smooth except for small area of finely aciculate or granular sculpture centrally in *Clarkinella*), hypopygium striate along median line (hypopygium not striate along median line in *Clarkinella*).

Neoclarkinella also resembles the genus *Xenogaster* Mason (Mason 1981) in having coarsely punctate mesonotum, forewing without areolet, propodeum with a midlongitudinal carina and a basal transverse carina, T2 subtriangular and T3 longer than T2, ovipositor sheath hairy throughout their pigmented part. But *Neoclarkinella* differs from *Xenogaster* Mason in having large and triangular scutellar lunules (lateral lunules of scutellum absent in *Xenogaster*), propodeum dull (propodeum mostly shiny in *Xenogaster*), T1 about 4x as long as its apex, narrowed at the apex and without a median groove (in *Xenogaster* T1 nearly twice as long as wide, basally parallel sided, broadly rounded on the apical 0.4 and with a sharp median groove basally), ovipositor longer than hind tibia (ovipositor shorter than hind tibia in *Xenogaster*), hypopygium large, nearly half as long as abdomen, striated along the median line (in *Xenogaster* hypopygium short and not striated).

Neoclarkinella nilamburensis (Sumodan & Narendran) comb. nov.
(Figs. 1-6)

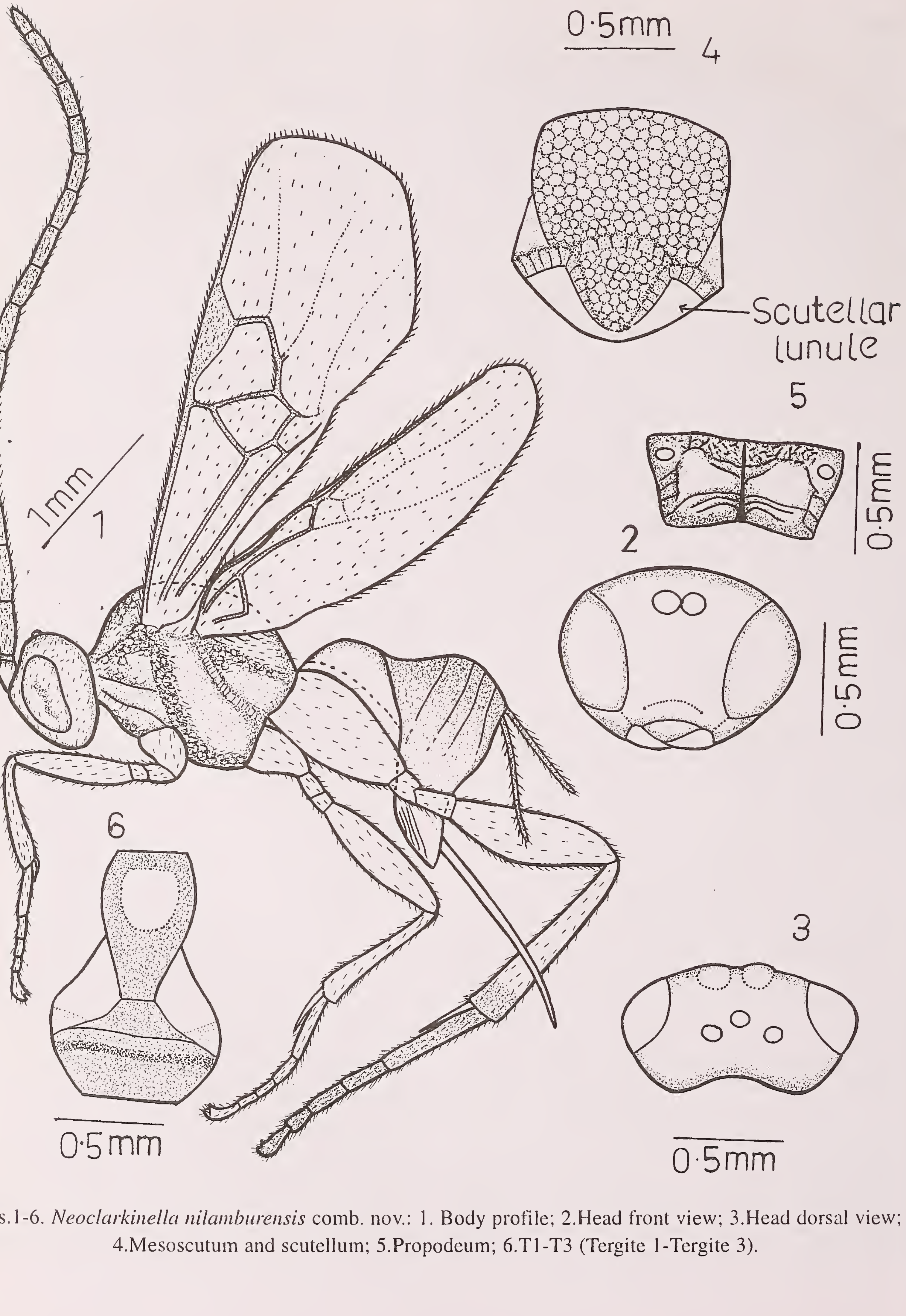
Apanteles nilamburensis Sumodan & Narendran, 1990. J. Ecol. 2(3). p.239 (DZCU) examined.

Metatype FEMALE: Length 2.9 mm (excluding ovipositor) ovipositor 1.4 mm; forewing 3 mm; antenna 3.7 mm. Head and thorax black, mandibles yellow; eyes brown with black patches; antenna black (except basal part of scape), scape testaceous basally; ocelli shining yellow; wings hyaline; tegula yellow, stigma and wing veins dark brown; fore and mid legs honey yellow, hind leg honey yellow except apex of hind tibia and hind tarsi which are dark brown; tibial spur pale yellow; tergites black except (T1 having U shaped yellow part basally); ovipositor yellow; ovipositor sheath black.

Head: Transverse, width 2x as its length; occiput smooth, vertex punctate, pubescent; OOL: POL-3:4; antenna longer than the body, all flagellomeres with 2 ranks of placodes. Flagellar formula: 2L/W=3.6, 14L/W=2, 8L/W=3, L2/14=1.8, W2/14=1; face lightly punctate, pubescent with a faint median longitudinal carina; eye length : malar space 9:2.

Thorax: Both upper and lower grooves of side of pronotum deep and crenulate, the area between them punctate; mesoscutum coarsely punctate, pubescent; prescutellar furrow crenulated; disc of scutellum coarsely punctate, sparsely pubescent; propodeum dull with a strong mid-longitudinal carina and a transverse carina at basal one-third, remaining parts with few carinulae.

Wings: Stigma shorter than metacarp, breadth of stigma shorter than r, r shorter than r-m, breadth of stigma equal to recurrent; hind coxa shiny, punctate, longer than first three tergites combined, longer hind tibial spur longer than half metatarsus


0·5mm
4
Scutellar lunule
5
0·5mm
2
0·5mm
1mm
1
6
0·5mm
3
0·5mm

Figs.1-6. *Neoclarkinella nilamburensis* comb. nov.: 1. Body profile; 2.Head front view; 3.Head dorsal view; 4.Mesoscutum and scutellum; 5.Propodeum; 6.T1-T3 (Tergite 1-Tergite 3).

and shorter spur one-third of it.

Gaster: T1 at apex 0.43x as wide as base, aciculate; T2 length 0.23x length of T1, 0.6x of T3, apical width 3x length, basal width = length; T3 longer than T2, T2 and T3 almost smooth, but sparsely punctate at apex, T3 with a transverse depression basally; remaining tergites smooth and laterally compressed; ovipositor sheath longer than metatarsus, but shorter than hind femora; hypopygium about half as long as abdomen, 0.5x as long as hind tibia, apical and ventral margins, in profile, making an angle of 50°.

MALE: Characters same as that of female.

Metatype FEMALE: INDIA, Kerala, Anakatty, T.C. Narendran, 7.i.1989. Other materials examined: 1 Male, INDIA, Kerala, Neendakara, T.C. Narendran, 22.ii.1987; 1 Male, INDIA, Kerala, C.U. Campus, T.C. Narendran, 1988. (All specimens deposited in the collections of Department of Zoology, University of Calicut).

Note: Apart from the above materials the original Holotype and Paratypes of *Apanteles nilamburensis* Sumodan and Narendran (1990) were also studied.

Etymology: *Neoclarkinella*, name derived from *Clarkinella*, owing to the close resemblance of this genus to *Clarkinella* Mason.

ACKNOWLEDGEMENTS

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THE GENUS *MACROCHELES* LATREILLE (ACARINA: MACROCHELIDAE) IN INDIA - ADDITIONAL NEW SPECIES AND NEW RECORDS ASSOCIATED WITH DUNG BEETLES (COLEOPTERA: SCARABAEIDAE) FROM SOUTH INDIA[1]

RANJIT KUMAR ROY[2]

(*With sixteen text-figures*)

Additional new species of insecticolous *Macrocheles*, namely *M. erichsonii* and *M. quadrilineatus* are described from South India. In addition, the paper presents further distributional records for *M. malabaricus* Evans & Hyatt, *M. nevernalis* Evans & Hyatt, *M. ceylonicus* Evans & Hyatt from Peninsular India.

INTRODUCTION

In part IV of the series (Roy 1994a), two new species of insecticolous *Macrocheles*, namely *M. punctovariata* and *M. sisiri* were described from Karnataka. The present contribution describes two more new species from South India. The present paper is based on material recovered from dung beetles collected from Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. In addition to the description of two new species (*M. erichsonii* and *M. quadrilineatus*), the paper gives new distributional records for *M. malabaricus, M. nevernalis* and *M. ceylonicus* described by Evans and Hyatt (1963).

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[1] Accepted February 1996. This is the seventh paper in the series. "Studies on Indian Macrocheles".

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M. malabaricus, earlier known only from Malabar, has been recorded from Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. While the other two species, initially known to be distributed only in Tamil Nadu, are now found in the other southern states as well.

The collections were made on three field collecting trips undertaken by me during 1980, 1988 and 1992.

An earlier publication in the series (Roy 1994a) was based on the examination of 7 specimens of *Heliocopris* sp.1 revealing *M. punctovariata*, a new species (total 8 females and a male recovered), and 10 specimens of *Copris* sp.1 revealing the second new species, namely *M. sisiri* (total 19 females recovered). Seventeen specimens of beetle material utilised in the study were also part of the total collection of beetles harbouring macrochelid mites during the present course of study.

The beetles were usually collected under street lights after 9 p.m., till midnight and also from dairy farms using a petromax lantern as the source of illumination to attract beetles and also by laying traps baited with dung in the vicinity of cattle sheds.

Four hundred and two coprid beetles were collected during the field trips. Mites belonging to six families were represented, namely the Macrochelidae, Pachylaelapidae, Eviphididae, Parasitidae, Uropodidae and Ascidae. The family Macrochelidae was found on 302 beetles, either exclusively or with phoretic non-macrochelid mites. Another 68 beetles harboured only non-macrochelid mites and the remaining beetles carried no mites. *Macrocheles* fauna recovered from 133 beetle specimens (material comprising 18 species of Coprid beetles) out of the total collection of 302 beetles is being presented in this series. The other macrochelid genera represented in the material are *Neopodocinum* Oudemans and *Glyptholaspis* Filipponi & Pegazzano. The former genus was recorded earlier (Roy 1994b) in a preliminary report and the latter genus was treated in an earlier publication (Roy 1988). Additional information now available on both the genera, together with information following completion of the unexamined material on the family Macrochelidae would be dealt with in subsequent publications.

In recent years, the largest study on phoretic *Macrocheles* associated with dung beetles was conducted by Wallace (1986) in Australia. The study was based on the examination of a large collection of beetles maintained in the Australian National Insect Collection (ANIC) housed at Commonwealth Scientific and Industrial Research Organisation (CSIRO), Division of Entomology, Canberra and nine species of *Macrocheles* phoretic on dung beetles were reported by Wallace (loc. cit.). Bhat *et al.* (1983) reported two adult females of *Nothrholaspis* sp. recovered from *Rattus rattus gangutrianus* and *Suncus murinus* from India. Berlese (1918) erected the genus *Nothrholaspis* and it was included in the family Macrochelidae by Vitzthum (1930). The genus is no longer valid and it has been synonymised with the genus *Macrocheles* by Evans & Browning (1956) comprising the largest number of species among mesostigmatids. Bhat *et al.* (loc. cit.) also collected nymphs of *Nothrholaspis* sp. from man (probably the only record), cattle sheds, chicken coops and *Rattus rattus gangutrianus* from the states of Himachal Pradesh, Uttar Pradesh and Sikkim. The female specimens collected by them may be members of the *glaber* group (unpublished research data under preparation) and they occasionally become phoretic on insects (beetles and synanthropic flies) and often on vertebrates. Nymphs excluding the genus *Neopodocinum* among the Macrochelidae are non-phoretic. Pending examination of the material collected by Bhat *et al.*, the identity of the specimens remain doubtful.

Phoresy is a form of commensalism, an association evolved between forms capable of fast movement (insects and vertebrates) and others (mites and nematodes) lacking that capability, through co-sharing a common habitat — the latter forms exploit the former to their advantage for quick dispersal in search of a suitable habitat when adverse conditions threaten their survival in a particular habitat. Adaptive trends towards a phoretic mode of life are seen among members of the genus *Macrocheles* accompanied by cheliceral modification for grasping the host body (Evans and Hyatt 1963) as well as reduction in the size of the ventral shields together with the degeneration of sclerotisation to reduce body weight in the true phoretic forms, in contrast to the members that only occasionally become phoretic (Unspecialised phoresy). *Scarabaeus* sp.1 with *M. perglaber* Fil & Pegg, grasping bristles around the mouth parts of the beetle, together with soil nematodes phoretic on the mite has been collected on two occasions from light traps at Dibrugarh during the present study.

The primary aim of the study is to provide information on biological resources associated with various types of dung, which would be the essential prerequisite to stimulate applied research focussing attention on other biological parameters like feeding habits, food preferences and behavioural relationships among the dung dwellers leading to the evaluation of their possibility as biological control agents. In the developed countries the trend of applied acarological research has been directed towards the goal of controlling synanthropic flies by employing some species of *Macrocheles* occurring in dung with considerable success. In recent years in Malaysia studies aiming at similar objectives have been initiated by Ho and Ismail (1988,1990); Ho (1990) and Ho and Auemetua (1990).

The material is in my collection. Measurements cited in the text are in micrometres.

Methods

Mites were recovered from beetle hosts using a fine brush or often with a needle and placed in lactophenol, which was then heated until the mites were clean enough for microscopic examination. Mites were usually found lodged around coxal cavities, mouth parts and under the elytrae. Camera lucida drawings were prepared from temporary mounts. Tarsus II of female was drawn in *situ.* Chelicerae of both sexes, legs II and IV of male were dissected for illustrations. Heinze-PVA mounting medium was used for mounting the types and the dissected parts on slides. The other specimens, after microscopic study, were preserved in 70% alcohol.

Description of species

1. **Macrocheles erichsonii** sp. nov.

FEMALE (Figs. 1-5) : Dorsal shield (Fig. 1) 606-652 long, 333-348 wide, faintly reticulate. Vertical setae, (j1) distally plumose, their bases almost contiguous, setae j4, z4, Z3, Z4, S5 and Z5 distally plumose; other dorsal setae pointed and simple. Extra-marginal setae simple.

Sternal shield (Fig. 2) granulated throughout and covered with punctures; *l. m. t.* and *l. ang.* present; sternal setae smooth. Metasternal shields each with a simple seta. Genital shield ornamented with punctate lines, genital setae smooth at posterolateral corners. Ventrianal shield 182-212 long, 182-197 wide, ornamented with punctate transverse lines; ventrianal setae fairly long and smooth.

Gnathosoma with five rows of deutosternal denticles. Tectum as shown in Fig. 3. Both movable and fixed digit of chelicera (Fig. 4) bidentate; cheliceral brush more than half the length of movable digit.

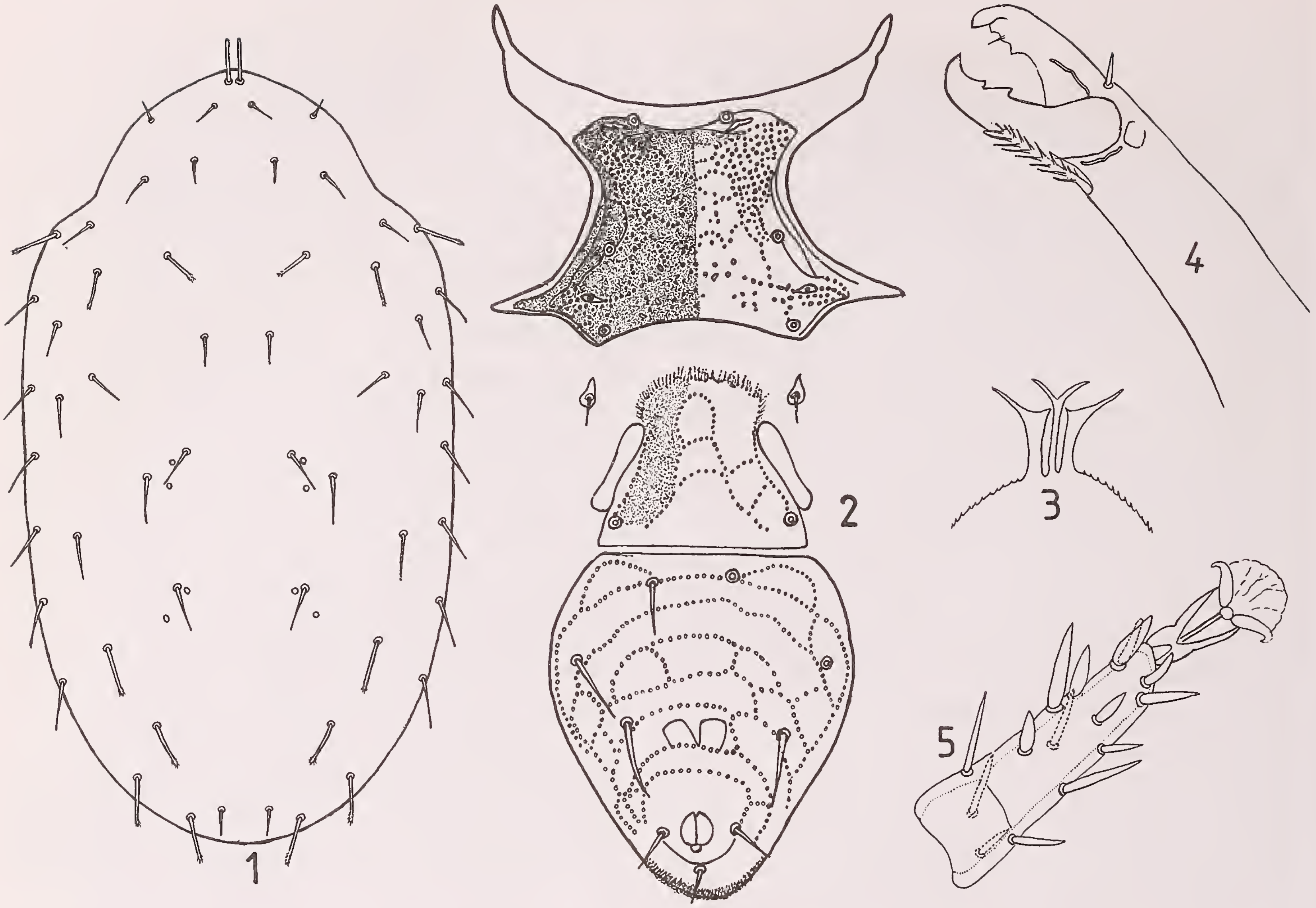
Approximate lengths of legs (excluding pretarsi): I-424; II-303; III-288; IV-424. Tarsus I (90) longer than tibia I (75), Tarsus II (Fig. 5) 106; tibia II-75. Genu IV with six simple setae.

MALE (Figs. 6-11). Dorsal shield (Fig. 6) 530-575 long, 288-333 wide, ornamentation as in female, attenuated posteriorly and bearing 30 pairs of setae. Setae j1, j4, z4, r3, Z4, j5, S5 and Z5 pilose.

Genital orifice presternal in position. Sternitigenital shield (Fig. 7) 227 long, 121-136 wide, non-reticulate and with five pairs of simple setae. Ventrianal shield (Fig.7) 166-197 long, 152-182 wide, devoid of reticulation and with 9 simple setae.

Gnathosoma as in female. Tectum as shown in Fig. 8. Chelicera (Fig. 9) with movable digit unidentate; fixed digit bidentate; spermatophoral process long; cheliceral brush two-thirds of movable digit.

Approximate lengths of legs (excluding pretarsi): I-439; II-318; III-242; IV-424. Femur II



Figs. 1-5: *Macrocheles erichsonii* sp. nov. Female: Fig. 1. Dorsal Shield; Fig. 2. Venter; Fig. 3. Tectum; Fig. 4. Chelicera; Fig. 5. Tarsus II.

(Fig. 10) with a prominent lateral spur; tarsus II with a protuberance (Fig. 10); trochanter and femur IV (Fig. 11) spurred; tarsus IV (Fig. 11) with a protuberance.

Material Examined: *Holotype*: FEMALE, INDIA: Andhra Pradesh: Arku Valley, 20.iii.1980, ex *Scarabaeus erichsoni* Harold; *Allotype* male, Tamil Nadu: Coimbatore, Tamil Nadu Agricultural University Campus, Central Dairy Farm, 13.iii.1980, ex manure heaps; *Paratypes*: 1 female, Coimbatore, near Central market, 16.ii.1992, ex *Onthophagus orientalis* Harold; 2 females, Nilgiri Hills, Ootacamund, Botanical Garden, 18.ii.1992, ex *O. orientalis*; 1 female, Nilgiri Hills; Pykara, village area, 19.ii.1992, ex *Catharsius molossus* L. ; 3 males, Coimbatore, TNAU Campus, Central Dairy Farm, 13.iii.1980, ex manure heaps; 6 females, Nagercoil, 3.iii.1992, ex *Scarabaeus erichsoni*; 2 females, Madras, Deer Park, 15.iii.1992, ex *Scarabaeus erichsoni;* 3 females, Andhra Pradesh: Visakhapatnam, cattle shed near Andhra University campus, 30.iii.1992, ex *Scarabaeus brahminus* Cast; 2 females, Karnataka: Mysore, Zoo Garden, 16.iii.1980, ex *Gymnopleurus maculosus* McLeay; 1 female, Bangalore, Nandi Hills, 10.viii.1988, ex *Copris spinator* Harold; 2 females, Kerala: Trivandrum, outskirts of Rly. Station, 2.iii.1992, ex *Catharsius granulatus* Sharp.

Distribution: INDIA: Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

Remarks: *Macrocheles erichsonii* is close to *M. robustulus* (Berlese) in respect of punctate ornamentation of the sternal shield and also in dorsal chaetotaxy. *M. robustulus* has been redescribed as *Macrocheles punctillatus* Willmann, 1939 by Bregetova and Koroleva (1960) and as *M.*

rothamstedensis by Evans and Browning (1956). Costa (1966) also illustrated the species. Setae j1, j4, z4, r2, S5, Z5 and Z3-4 are plumose in *erichsonii*. Plumose nature of setae may vary; seta z2 plumose as illustrated by Evans and Browning (Fig. 14, p. 15, 1956); z2 being simple as shown by Costa (1967), Bregetova and Koroleva (1960); the seta is simple in the present species. The sternal shield in *erichsoni* is finely granular and *l. ang.* and *l. o. p.* discernible, even though formed by punctures, but in *robustulus* these *liniae* are not discernible as illustrated by Bregetova and Koroleva (Fig. 91, p. 127, 1960). Besides the shape and ornamentation of the ventrianal shield of *robustulus* figured by Bregetova and Koroleva is also different. The occurrence of this species in manure heaps was reported by Axtell (1961), Costa (1967). Ridsdill Smith and Hull (1984) recorded a good collection of *M. robustulus* in dung baited pitfall traps in Western Australia. This species could not be located on any of the dung beetles or from manure heaps during the present study. *M. erichsonii* belongs to *robustulus* group for its affinities with *M. robustulus*.

2. ***Macrocheles quadrilineatus*** sp. nov.

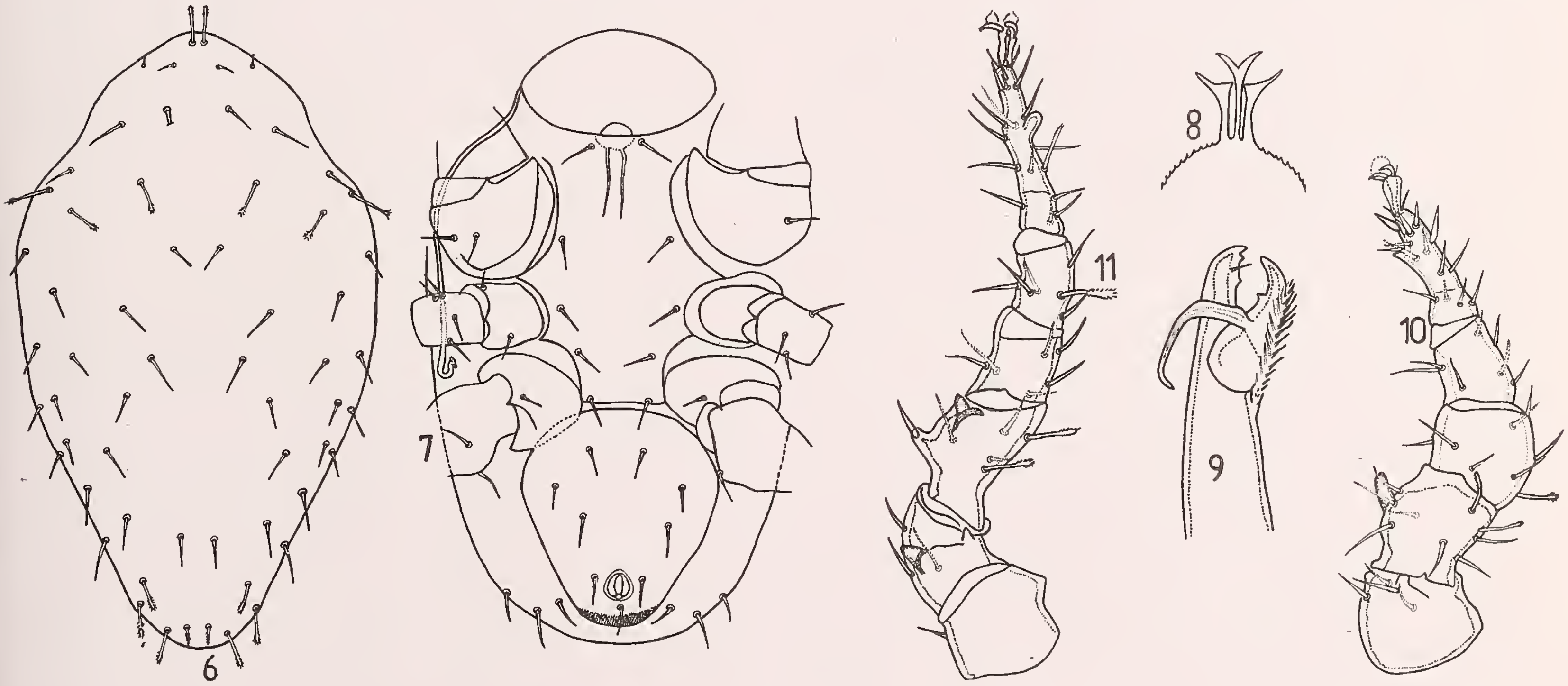
FEMALE (Figs. 12-16) : Dorsal shield (Fig. 12) 500-600 long, 315-345 wide, reticulate and bearing 28 pairs of simple setae, insertions of verticals adjacent.

Sternal shield (Fig. 13) granular, *l.o.p.* extending almost to the centre of the shield; *l.o.a.* also distinct, *l. arc.* and *l.a.t.* well-marked; sternal setae smooth.

Metasternal shields elongate, each with a simple seta, subequal to sternals. Genital shield granular, truncated posteriorly, ornamented with punctate lines along accessory sclerites and a medial punctate line in the form of an inverted ‘U’; genital setae smooth. Ventrianal shield 165-180 long, 150 wide, finely granular, subtriangular, ornamented with faint transverse lines; ventrianal setae in most of the specimens lost. Metapodal shields as usual, close to the coxae IV. Ventrolateral integument striate, integumental setae short and simple. Stigmata typical of genus, peritremes each terminating anterodorsally to a median point between insertions of j1 and z1.

Gnathosoma with five rows of deutosternal denticles. Tectum as illustrated in Fig. 14. Chelicera as shown in Fig. 15. Cheliceral brush more than half the length of the movable digit.

Approximate lengths of legs (excluding



Figs.6-11: *Macrocheles erichsonii* sp. nov. Male: Fig.6. Dorsal Shield; Fig.7. Venter; Fig.8. Tectum; Fig.9. Chelicera; Fig.10. Trochanter, femur, genu, tibia and tarsus of leg II. Fig.11. Coxa, trochanter, femur, genu, tibia and tarsus of leg IV.

pretarsi): I-315; II-375; III-300; IV-450. Tarsus I (90) longer than tibia I (60). Tarsus II (Fig. 16) (90); tibia II (60). Genu IV with six simple setae.

MALE: Unknown.

Material Examined: *Holotype*: FEMALE: INDIA: Karnataka: Mysore, Zoo Garden, 16.iii.1980, ex *Scarabaeus brahminus*; *Paratypes*: 5 females collection data as that of holotype; 5 females, Tamil Nadu: Nagercoil, 3.iii.1992, ex *Heliocopris midas* (F.); 4 females, Tirunelveli, 11.iii.1992, ex *Heliocopris bucephalus* (F.); 4 females, Kanyakumari, 4.iii.1992, ex *Gymnopleurus maculosus* McLeay; 2 females, Tirunelveli, 11.iii.1992, ex *Onitis singhalensis* Lansb.

Distribution: INDIA: Karnataka and Tamil Nadu.

Remarks: Setae of both dorsal and ventral shields in most of the specimens were lost. Altogether 21 specimens could be recovered from beetle hosts on which this description has been based.

3. ***Macrocheles malabaricus*** Evans & Hyatt

Macrocheles malabaricus Evans and Hyatt, 1963, *Bull. Brit. Mus. (Nat. Hist.)* 9(9): 354.

Material examined: 1 female, Andhra Pradesh: Guntur, 19.iii.1992, ex *Heliocopris bucephalus*; 2 females, Vijaywada, 18.iii.1992, ex *Heliocopris bucephalus*; 2 females, Eluru, 17.iii.1992, ex *Heliocopris dominus* Bates; 2 females, Karnataka: Gundelpet, 15.ii.1992, ex *Catharsius molossus* L.; 3 females, Bangalore, GKVK campus, 10.viii.1988, ex *Heliocopris dominus*; 2 females, Bangalore, IISc campus, 11.viii.1988, ex *Onitis singhalensis* Lansb; 4 females, Bangalore, Krishnarajapuram, 11.viii.1988, ex *Onitis subopacus* Arrow; 1 female, Bangalore, Nandi hills, 10.viii.1988, ex *Onitis philemon*; 6 females, Bangalore, Golap Bagh, 12.viii.1988, ex *Copris* sp.2; 1 female, Kerala: Quilon, 1.iii.1992, ex *Catharsius granulatus* Sharp; 1 female, Trivandrum, Kerala University campus, 2.iii.1992, ex *Onthophagus cervus* (F.); 3 females, Palghat, 14.iii.1980, ex *O. unifasciatus* F.; 2 females, Tamil Nadu: Coimbatore, TNAU campus, Dairy Farm, 13.iii.1980, ex *O. unifasciatus*; 4 females, Ootacamund, Botanical Garden, 18.ii.1992, ex *O. orientalis*; 1 female, Kodaikanal, Bryant Park, 12.iii.1980, ex *O. orientalis*; 2 females Rameswaram, 7.iii.1992, ex *O. cervus* (F.); 1 female, Pamban area, 7.iii.1992, ex *Onitis philemon*; 3 females Dhanushkodi, 8.iii.1992, ex *Onitis singhalensis* Lansb.

Distribution: INDIA: Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

Remarks: Evans and Hyatt (1963) described this species based on a single female off *Gymnopleurus maculosus* McLeay in the collections of the British Museum (Natural History), London. Since 1963, this is the first record of the species from south India. The species seems to be distributed only in peninsular India.

4. **Macrocheles nevernalis** Evans & Hyatt

Macrocheles nevernalis Evans & Hyatt, 1963, *Bull. Brit. Mus. (Nat. Hist.)* 9(9): 361.

Material examined: 1 female, Andhra Pradesh: Guntur, 19.iii.1992, ex *Oniticellus* sp.1; 4 females, Vijaywada, 18.iii.1992, ex *Onitis philemon*; 3 females, Visakhapatnam, cattle shed near Andhra University campus, 30.iii.1992, ex *Copris* sp.2; 4 females, Karnataka: Bangalore, Golap Bagh, 12.viii.1988, ex *Copris spinator*; 3 females, Bangalore, Nandi Hills, 10.viii.1988, ex *Catharsius molossus*; 4 females, Kerala: Trivandrum, Kerala University campus, 2.iii.1992, ex *Onthophagus orientalis*; 5 females, Tamil Nadu: Arkonam, 13.iii.1992, ex *Scarabaeus erichsoni*.

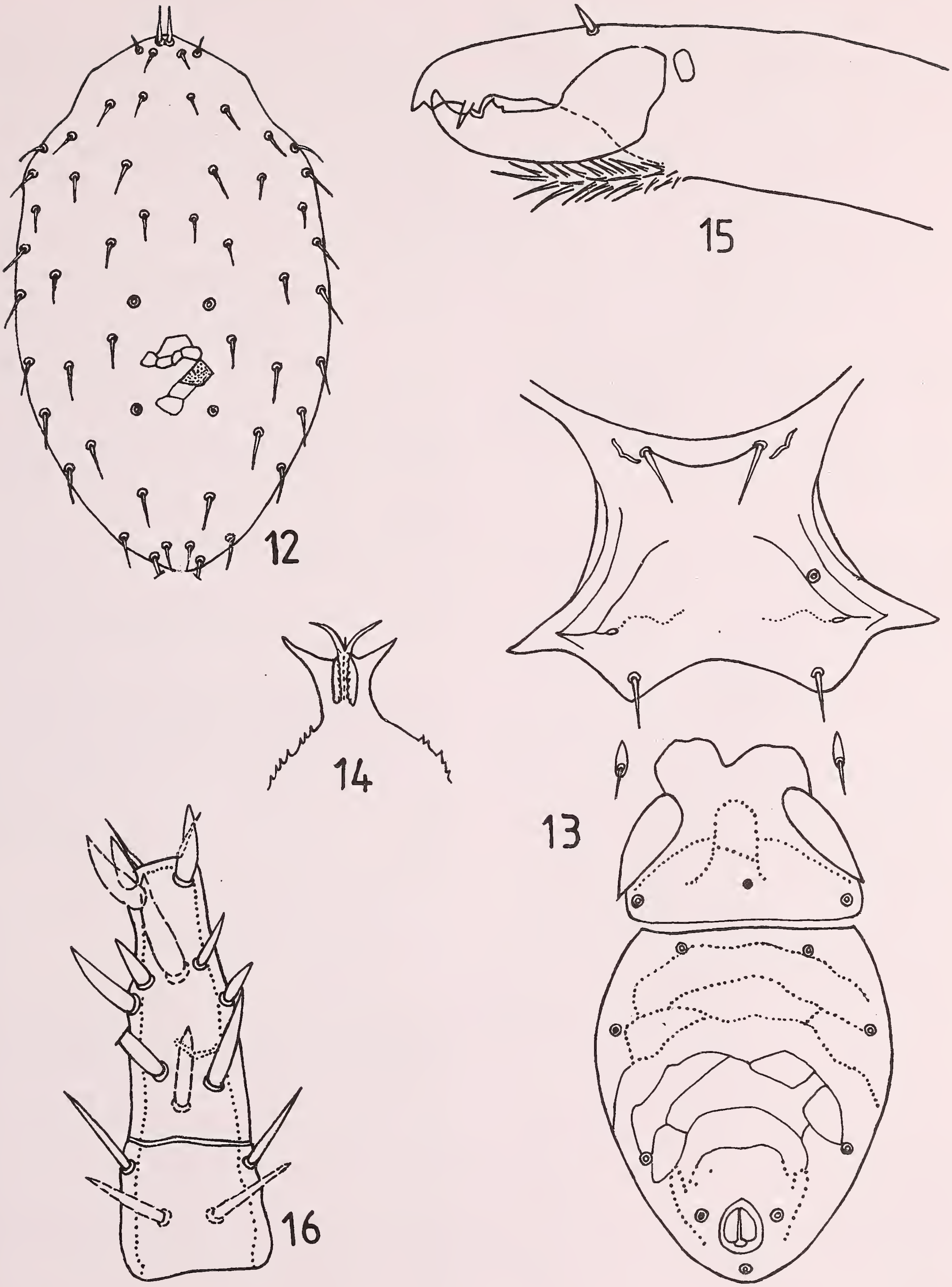
Distribution: INDIA: Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

Remarks: Evans and Hyatt's (1963) description of *nevernalis* was based on 4 females collected ex *Scarabaeus brahminus* cast at Namakal, Salem, Tamil Nadu.

5. **Macrocheles ceylonicus** Evans & Hyatt

Macrocheles ceylonicus Evans & Hyatt, 1963, *Bull. Brit. Mus. (Nat. Hist.)* 9(9): 341.

Material Examined: 1 female, Andhra Pradesh: Rajahmundry, 20.iii.1992, ex *Scarabaeus erichsoni*; 7 females Rajahmundry, 22.iii.1992, ex *Scarabaeus* sp.1; 1 female, Gudur, 11.iii.1992, ex *Copris* sp. 2; 4 females, Karnataka: Gundelpet, 15.ii.1992, ex *Catharsius molossus*; 1 female,



Figs.12-16. *Macrocheles quadrilineatus* sp. nov. Female: Fig.12 Dorsal Shield; Fig.13. Venter; Fig.14. Tectum; Fig.15. Chelicera; Fig.16. Tarsus II.

Kerala: Quilon, 1.iii.1992, ex *Catharsius molossus*; 4 females, Tamil Nadu: Kodaikanal, Bryant Park, 12.iii.1980, ex *Scarabaeus brahminus*; 6 females, Rameswaram, 7.iii.1992, ex *Onthophagus orientalis;* 5 females, Pamban area, 7.iii.1992, ex *Onthophagus unifasciatus*.

TABLE 1

LIST OF KNOWN BEETLE HOSTS FOR *M. erichsonii* SP. NOV., *M. quadrilineatus* SP. NOV., *M. malabaricus* EVANS & HYATT, *M. nevernalis* EVANS & HYATT, AND *M. ceylonicus* EVANS & HYATT

M. erichsonii (female only),	Male nonphoretic
Beetle host	Number of Collections
Scarabaeus erichsoni	9
Scarabaeus brahminus	3
Copris spinator	1
Catharsius molossus	3
Catharsius granulatus	1
Gymnopleurus maculosus	1
Onthophagus orientalis	3
Total hosts: 7	Total Collections: 21

M. quadrilineatus (Female only)

Beetle host	Number of Collections
Scarabaeus brahminus	6
Heliocopris midas	5
Heliocopris bucephalus	4
Gymnopleurus maculosus	4
Onitis singhalensis	2
Total hosts: 5	Total Collections: 21

M. malabaricus (Female only)

Beetle host	Number of Collections
Catharsius molossus	2
Catharsius granulatus	1
Copris sp. 2	6
Heliocopris bucephalus	2
Heliocopris dominus	5
Onthophagus cervus	3
Onthophagus orientalis	4
Onthophagus unifasciatus	5
Onitis philemon	2
Onitis singhalensis	5
Onitis subopacus	4
Total hosts: 11	Total Collections: 39

M. nevernalis (Female only)

Beetle host	Number of Collections
Catharsius molossus	3
Copris spinator	4
Copris sp. 2	5
Onthophagus orientalis	4
Oniticellus sp. 1	1
Onitis philemon	4
Scarabaeus erichsoni	5
Total hosts: 7	Total Collections: 26

M. ceylonicus (Female only)

Beetle host	Number of Collections
Catharsius molossus	4
Copris sp. 2	1
Onthophagus orientalis	6
Onthophagus unifasciatus	5
Scarabaeus erichsoni	1
Scarabaeus brahminus	2
Scarabaeus sp. 1	7
Total hosts: 7	Total Collections: 26

Distribution: SRI LANKA and INDIA: Andhra Pradesh, Kerala and Tamil Nadu.

Remarks: *Macrocheles ceylonicus* was described by Evans and Hyatt (1963) based on 3 females collected ex *Scarabaeus erichsoni* at Colombo, Sri Lanka and six females recovered from the same host collected from Madras.

DISCUSSION

Table 1 presents a list of beetle hosts comprising 18 species of dung beetles totalling 133 specimens as the source material for the present communication. Two species of beetle hosts represented by a collection of 17 specimens were utilised in Part IV of the series. Altogether seven species of phoretic *Macrocheles* (4 new species and three earlier known species) have been recovered from 20 species of beetle hosts (Total number of specimens 150) from southern India. *M. punctovariata* (Roy) and *M. sisiri* (Roy) are unrepresented in the present material.

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OBITUARIES

B.K. TIKADER
(1928-1994)

Dr. Benoy Krishna Tikader, M.Sc., Ph.D., D.Sc., was born on 1st June, 1928, at Joydihi, District Khulna (now in Bangladesh).

Dr. Tikader had a difficult childhood, in a family of limited income and financial constrains. It was with his indomitable spirit only, that he could finish his schooling in a village in undivided rural Bengal. His memories of rural life had taught him the sense of being a part of the community, the joy of caring and sharing.

The village boy, on arrival at Calcutta, was perhaps most intrigued by the way of life of the city. Nevertheless, he was quick in adapting without losing the basic values of sensitive humane approach. His simplistic rather rustic manners earned him a unique popularity. He made many friends from college days, who later sealed the bond of long lasting friendship. He, in his own characteristic way, finished graduation with distinction and sailed through post-graduate degree in Zoology from the University of Calcutta.

After a short stint as a Lecturer in Zoology, Dr. Tikader joined the Zoological Survey of India in September, 1956. He was fascinated with arachnids, particularly spiders. He felt strongly that this group which offered so many species of diverse form and behaviour was so little known and was worthy of much closer attention. He made extensive collection of spiders in every part of the country and diverse ecosystems. Later, for his outstanding researches on spiders he was awarded the degree of Ph.D. and D.Sc. by the Calcutta University in 1962 and 1969 respectively. Dr. Tikader had described numerous new species of spiders and was recognised as an authority on this group. Besides spiders he had keen interest on wildlife and nature conservation problems; photography was his most favoured hobby during his field work.

His humane nature was evident at an early age. He was a very cordial person who tried his best to comfort and console the distressed irrespective of caste and creed. Later in his office (Zoological Survey of India, Calcutta), he was always very keen to hear patiently the problems and sufferings of his subordinates and tried to solve these in an amicable manner.

Dr. Tikader was a prolific and accomplished writer. He has to his credit two volumes on Spiders and a volume on Scorpions under the famed FAUNA OF INDIA series, besides numerous scientific papers. His books entitled "Threatened Animals of India", "Birds of Andaman & Nicobar Islands", "Handbook of Indian Testudines", "Glimpses of Animal Life of Andaman & Nicobar Islands" and "Handbook on Indian Spiders", have been widely acclaimed in India and abroad.

Dr. Tikader had held varied positions in the Zoological Survey of India and headed both the Eastern and Western Regional Stations at Shillong and Pune, respectively. He returned to the Headquarters at Calcutta as the Director of the Zoological Survey of India on 31st March, 1981. During his tenure he showed a prodigious capacity for work. A long list of his achievements as Director, ZSI, can be given of which one would always remember his zeal towards construction of 10 storied Headquarter building at Calcutta and initiation of MARC project at Digha.

In recognition of his scientific contribution, Dr. Tikader was elected as a Fellow of Zoological Society of India, a Correspondent of the Centre Internationale de Documentation Arachnologigue (CIDA), Paris for India, and Vice President of the Indian Association of Biological Sciences. Dr. Tikader was also honoured by the Asiatic Society, Calcutta and was awarded the prestigious - Joy Govind Law Medal in 1992.

Dr. Tikader died on 12th August, 1994 at Calcutta at the age of 66 after a brief illness. He is survived by his wife, two sons and a daughter. His loss would surely be felt by his friends, colleagues and associates.

A.K. GHOSH

List of papers published in the JBNHS

(1960): On some new species of spiders (Arachnida) of the family Thomisidae from India. 57:173-183.
(1960): Revision of Indian spiders of the genus *Cyrtarachne* (Argiopidae:Arachnida). 57: 547-556.
(1961): Protective devices of some orb-weaving spiders from India. 58: 826-829.
(1962): Studies on some spiders of the genus *Oecobius* (Family Oecobiidae) from India. 59: 682-685.
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(1964): Observations on the caecilian *Ichthyophis beddomii* Peters from Kotegebar, District Chikamangalur, Mysore. 61: 697.
(1968): Observations on the limbless lizard *Ophisaurus gracilis* (Gray) from Shillong, Assam. 65: 233.
(1968): Gregariousness and mimicry during cocoon stage by the butterfly *Eurema hecabe* (L.). 65: 242-243.
(1968): A new spider of the genus *Ischnothyreus* Simon (Family Oonopidae) from India. 65: 257-259.
(1969): Spider fauna of India: Calalogue and Bibliography. 66: 81-91.
(1969): Futher observations on the limbless lizard, *Ophisaurus gracilis* (Gray) from Shillong, Assam. 66: 382.
(1970): Spider fauna of India: Catalogue and Bibliography.66: 491-499.
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(1872): Spider fauna of India: Catalogue and Bibliography. 69: 91-101.
(1973): Spider fauna of India: Catalogue and Bibliography. 70: 95-103.
(1975): A new species of spider of the genus *Cheiracanthium* Koch (Family Clubionidae) from India. 72: 43-45.
(1975): A new species of spider of the genus *Ctenus* (Family:Ctenidae) from Meghalaya, India. 72: 791-793.
(1975): A new species of spider of the genus *Lutica* (Family Zodariidae) from India. 72:794-796.
(1975): A new species of spider of the genus *Plator* Simon (Family: Platoridae) from India.72:797-799.
(1976): Two new species of spiders of the genera *Cheiracanthium* Koch and *Clubiona* Latreille (Family: Clubionidae) from India. 73:1175-1177.
(1976): The ground activity of spiders (Araneae) and harvestmen (Phalangidae) in West Bengal, India. 73:121-141.
(1976): A new species of spider of the genus *Plator* Simon (Family-Platoridae) from Almora, India. 73:178-179.
(1976): Key to Indian spiders. 73: 356-370.
(1976): Redescription of a jumping spider *Harmochirus brachiatus* with a new record from India. 73: 410-411.
(1976): Redescription of type specimens of the species *Eucamptopus coronatus* Pocock and *Euprosthenops ellioti* (Cambridge) (Family Pisauridae) with critical notes. 73: 539-543.
(1977): A new species of scorpion of genus *Scorpiops* Peter (Famiily Vejovidae) from India.74: 140-143.
(1977): Description of two new species of wolf-spider (Family Lycosidae) from Ladakh, India. 74: 144-146.
(1977): Studies on some Mygalomorph spiders of the family (Tenizidae and Theraphosidae) from India.74:306-319.
(1977): Sexual dimorphism in the jumping spider *Phidippus pateli* Tikader (Family: Salicidae).74: 543-546.
(1978): Two new species of spider of the genus *Tharpyna* Koch from India (Family: Thomisidae).75: 903-905.
(1980): A new species of high altitude spider of the genus *Erigone* Audouin (Family: Erigonidae) from India. 77:490-491.
(1981): Studies on spiders of the genus *Lutica* Marx (Family-Zodariidae).78:139-142.

M. Krishnan

(1912-1996)

(*With a photograph*)

Mr. Krishnan who died on 18 February, 1996 at the age of 83 was India's quintessential Naturalist. For over four decades he held the centre stage of Indian Natural History.

Krishnan was born on 30 June 1912, at Perunkulam, Tirunelveli Dt., Tamil Nadu, the last of eight children of a family of considerable literary attainments. He had a liberal education graduating in Tamil, English, Botany and Zoology and finally a degree in law. All these subjects gave an excellent foundation to his writings, except perhaps law which seems to have been something of an afterthought or perhaps the result of family persuasion, as an elder brother retired as a Chief Justice of the Madras High Court.

Curiously enough Krishnan had a dichotomous career starting life as a commercial artist and till his 37th year he dabbled in various fields ending up the first half of his career as Political Secretary in the State of Sandur in Karnataka. With the merger of the State he finally stopped being a paid employee and started on the second leg of his career as a free-lance artist, writer, naturalist, and nature photographer and Krishnan at long last came into his own.

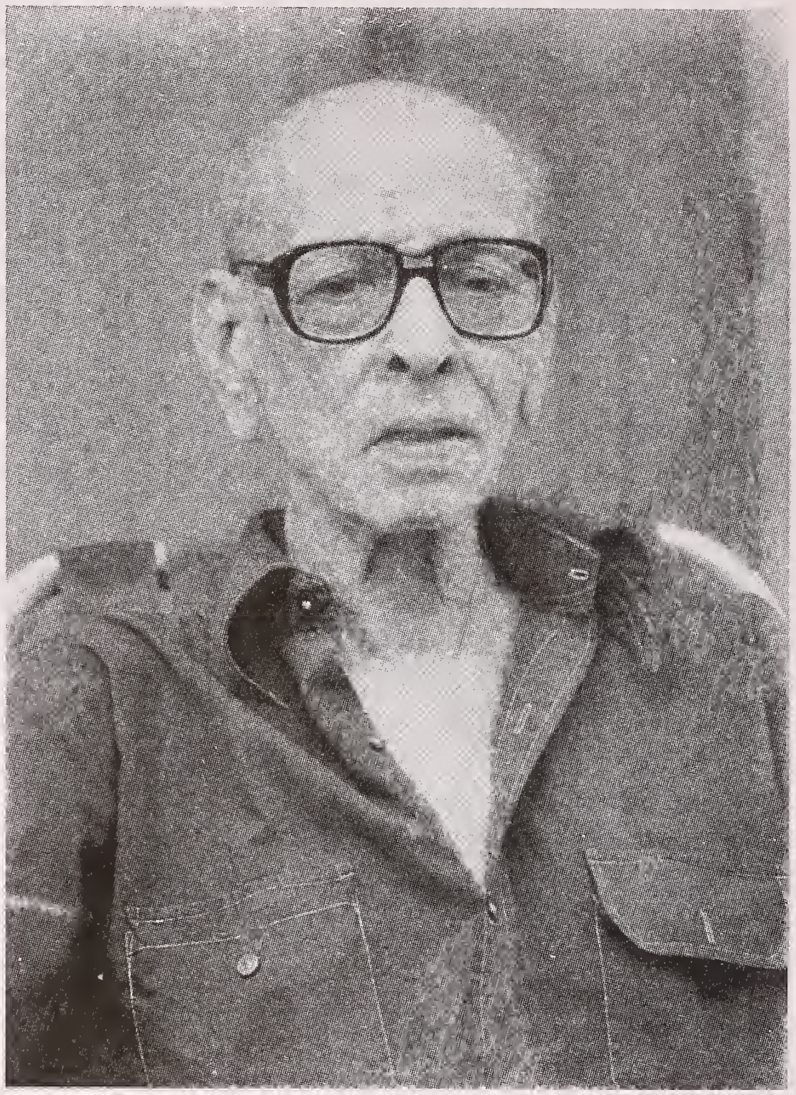
Mr. B. Vijayaraghavan, the President of the Madras Naturalists Society compares him with EHA (Edward Hamilton Aitken) whose delightful style of writing had a light hearted effervescence to it. Krishnan had a wry sense of humour but he differed from EHA in being very serious where natural history was concerned. Again quoting Mr. Vijayaraghavan.

"Krishnan scored over EHA in his scientific acumen, his vast experience of the jungles and his expert skill as a wildlife photographer.

Krishnan dedicated his book *Nights and Days: My book of India's Wildlife* (1985) to his readers to whom alone he felt he had a responsibility. He spoke of the enjoyment he had derived from his love of wildlife which in some measure he hoped to pass on to his readers. If the book fails in this, I can plead nothing in extenuation, for a professional can have no excuse for his ineptitude in his chosen field. He surely does not fail.

He never failed his readers. That was not easy for one who regularly wrote innumerable notes for newspapers and journals, obligated to meet deadlines, and on an incredible variety of topics in natural history, all based on his own experience and observations. The craftsmanship that went into every one of his pieces made them a delight to read. The balanced sentence, the well-turned phrase and the elegant idiom reigned supreme.

There are few writers on natural history who can write with scientific objectivity and without resort to poetic imagery and yet transmit to their readers some of their elation. Strange though it may seem, the serious observer of nature is often a dried-up specimen lacking in sensitivity. That was why Hazlitt referred to the naturalist who catches the glow-worm, carries it home with him in a box, and finds the next morning nothing but a little grey worm while the poet visits it in the evening when beneath the scented hawthorn and the crescent moon it has built itself a palace of emerald light. Krishnan showed us that a good naturalist-writer could be accurate and yet be enchanting.



M. Krishnan

Krishnan had a special empathy for elephants and was in his day the authority on the behaviour of elephants. His observations were accurate and meticulous as is evident from his study of the larger mammals of Peninsular India which he undertook under the prestigious Jawaharlal Nehru Fellowship (incidentally he was the first awardee). The results were published in a series of articles in this *Journal* and later in book form by the Society. His fortnightly column in the "Statesman" ran without a break for 46 years and was an editor's dream as the article was perfect in all respects and required no editing. In fact M. Krishnan was such a craftsman that whatever he wrote required no editing and when any editing was done it brought down his wrath on the unfortunate editor. I had once to shorten an article of his for inclusion in an anthology and I made the mistake of editing the article without consulting him. He was deeply hurt though he never showed his displeasure. He was always helpful with advice if he felt that a mistake had been made. I had once written an article for a Govt. of India publication at his instance which in the process of publication got mutilated beyond recognition. I wrote a sarcastic letter to the editor with a copy to Krishnan. He replied immediately cautioning me against sarcasm which he felt left a festering sore of resentment with the recipient.

It was in photography that Krishnan gave full expression to his talents. He worked exclusively in monochrome and such is the quality of his photography that they stood enlargements to any size he wanted. Krishnan's photographic studies of wildlife cannot be bettered. It would be a tragedy indeed if his negatives and his meticulous field notes, are not given the status of a national heritage, and protected as such.

Krishnan, in the course of his life picked up many awards; the Jawaharlal Nehru Fellowship, the Padma Shri and the Global 500 Roll of Honour for 1995.

He leaves behind his wife with whom he was to have celebrated his 60th wedding anniversary during the year and his son who is the Principal Chief Conservator or of Forests, Tamil Nadu.

J.C. DANIEL

LIST OF PAPERS PUBLISHED IN THE JBNHS

(1951): Koels (*Eudynamis scolopaceus*) eating the poisonous fruit of the yellow oleander. 50:943-945.
(1955): The Rosy Pastor in the Bellary Area.53:128.
(1965): Wild dogs. 62:543-545.
(1971): The esturine crocodile *Crocodilus porosus* Schneider off the Orissa coast. 67:573-574.
(1971): An ecological survey of the larger animals of peninsular India. 68:503-555.
(1972): An ecological survey of the larger animals of peninsular India. 69:26-54.
(1972): An ecological survey of the larger animals of peninsular India. 69:297-351.
(1972): An ecological survey of the larger animals of peninsular India. 69: 469-501.
(1974): R.H Waller's observations on wildlife sanctuaries in India. A partial rejoinder. 71:594-598.
(1978): Disconnected observations on a species of Scolapendra. 75:239-240.
(1978): Emotive kinships in the study of mammals.75:613-617.
(1980): The availability of nesting materials and nesting sites as vital factors in the gregarious breeding of Indian water birds.77:1143-1152.

REVIEWS

1. PALEOBOTANY - PLANTS OF THE PAST, THEIR EVOLUTION, PALEOENVIRONMENT AND APPLICATIONS IN EXPLORATION OF FOSSIL FUELS. By Shripad N. Agashe. pp. vii + 359 (24 x 15.5 cm), with many illustrations. New Delhi, 1995. Oxford and IBH Publishing Co. Ltd. Price. Rs. 150/-

The author deserves special compliments for fulfilling a long standing need for a text book in paleobotany, specially for Indian students with emphasis on Indian fossil floras. Except for Dr. Andrews' (1960) "Principles of paleobotany" no other published text book on paleobotany gives due consideration to paleopalynology, an aspect whose basis and applications have been brought out in this book.

The basic subject matter has been covered in 13 chapters which deal with systematic account of representative fossils of different plant groups starting from fungi to Angiosperms. Two useful chapters on Gondwana and Tertiary floras of India are added. Applications of paleobotany in considerations of paleofloras, paleoenvironment, coal and oil prospecting are dealt with in the last three chapters. The scope of the subject matter has been ably introduced, followed by basic information on history of paleobotany, geology of earth and the time scale, methods of geological age determination, types of plant preservations and the techniques employed to study them. Exhaustive references and a useful index have been appended. The book is suitably illustrated and the language is fluent.

The book will serve the purpose of not only graduate and post-graduate students of botany but also of basic geology, as claimed by the author. The price is also within the reach of students who would like to have their own copies.

There are, however, a number of shortcomings of different types in several chapters of the book which could be taken care of during publication of the new edition. Some of these are pin-pointed below:

1. Page 1: "Plant remains which are younger than 1 m.y. are normally studied in archeology". However, as per present concept plant remains associated with human history are studied in archeology and those beyond human history come under paleobotany.

2. Pages 27-28: Dendrochronology, counting of growth rings in animal shells and valves do not give absolute age in geological time scale as claimed in the book.

3. Page 47: It is stated that impression fossils represent only an imprint; the original organic material has been completely destroyed, while on page 210 *Glossopteris* leaves are claimed to be preserved as impressions with or without organic carbon content.

4. Page 52: The statement that "in petrifactions much of the original organic matter of the plant is preserved" is incorrect.

5. Chapter 6 on Precambrian Paleobiology refers to *Escherichia coli* found in coprolites belonging to Eocene age.

6. The concept of classification of major plant groups as per Taylor (1981) given on page 60-70 does not seem to have been followed consistently in the subsequent text; neither are the prefixes to major taxa used are as per code of ICBN though claimed to be so.

7. Page 125: Class Sphenopsida has been described to be containing 3 orders: Pseudoborniales, Sphenophyllales and Equisetales while in the text the order Calamitales is also added (p. 130).

8. In Chapter 19 Coniferophyta, it is stated that this group (division rank?) is divided into two classes: Cordaitopsida and Coniferopsida (p. 196) while in the text class Gnetopsida is also included and Coniferales, Ginkgoales are treated as orders of class Cordaitopsida (p. 202).

9. There is confusion in the use of terms 'System', 'Series' and 'Stages' while describing Gondwana flora. The book fails to introduce the monumental work of Ottokar Feistmantel.

10. Simple leaves of *Glossopteris* are termed as fronds (p. 210); *Vertebraria* - a root axis is included under male fructification of Glossopteris (p. 217). Pentoxyleae is included in Taxales (p. 240). The

terms 'Pentoxylease' and 'Pentoxylales' have been incoherently used. *Williumsonia sewardiana* is regarded as stem attributed to Williumsoniaceae (p. 249).

11. Chapter 21 Tertiary flora of India does not take into account recent contributions. Ample accumulation of data on Siwalik exposures is entirely omitted. *Palmocaulon.* (p. 260) is not valid as at present. New light thrown on affinities of *Cyclanthodendron, Tricoccites* and some others are not mentioned.

12. Birbal Sahni has been credited to have claimed the age of Deccan traps to range from Palaeocene to Eocene to Miocene (p. 271) though nobody has claimed Deccan traps to be as young as Miocene.

13. One ponders over the significance of some localities of Cuddalore sandstone series which are known only for preservation of Gymnosperm fossils (p. 273) though the age is claimed to be Miocene dominated by Angiosperm flora.

14. References appended have omitted some of those cited in the text. Tom and Taylors (1993) "The biology and evolution of plant fossils" and Rothwell's (1993) "Paleobotany and evolution of Plants" are not listed.

15. The concluding chapter giving a detailed account of the ongoing paleobotanical research activities in various parts of the world (page 2) is entirely missing.

Because of above mentioned drawbacks and because the two major chapters on Indian paleobotany, i.e. Gondwana flora and Tertiary flora, require comprehensive revision, the book as it stands today would not serve the purpose of research students.

A.R. KULKARNI

2. GREEN IMPERIALISM. By Richard H. Grove. pp. xiv + 540 (25.5 x 14 cm), with 23 illustrations. New Delhi, 1995. Oxford University Press. Price Rs. 375/-.

The book documents the origins and early history of environmentalism and correlates it with the 'explosion' of popular and governmental interest in environmental problems in recent years. It traces the role played by a cross current of ideas in the emergence of a coherent environmental thinking. This was brought about, as the book points out, though not very convincingly, by the emergence of professional scientists. We know for sure that traditional societies had their checks and balances in place which made the wise use of resources mandatory and practical.

Though, as the book rightly points out, these legitimate and sustainable demands went out of hand when they were meant to cater to unnatural conditions like war, this was true throughout history. The chronology of events presented in the book brings into focus very succinctly the involvement and concern of every major world civilization with environmental issues.

The book is divided into chapters which delve into the environmental history of Islands and early empires. Indigenous knowledge, climatic environmentalism, beginnings of global environmentalism. Professional science, oceanic islands and the East India Company, 1768-1838, The East India Company medical services and the emergence of state conservationism in India, 1760 - 1857.

While referring to the emergence of state conservationism in India, it acknowledges the permeation of indigenous Indian knowledge about the consequences of deforestation, this knowledge was directly instrumental at a number of stages in the formation of colonial perceptions of rates and mechanisms of environmental change. The author acknowledges, that on balance, indigenous knowledge, management and afforestation methods were more important to the evolution of the East India Company's environmental policy than any set of ideas imported from outside the country.

The book, while documenting available evidence, indicates that the seeds of modern conservationism developed as an integral part of the European encounter with the tropics and with local classifications and interpretations of the natural world and its symbolism. As colonial expansionism proceeded, the environmental experiences of Europeans and indigenous peoples living at the colonial periphery played a steadily more dominant and dynamic part in the construction of new European evaluations of nature and in the growing awareness of the destructive impact of European economic activity on the peoples and environments of the newly discovered and colonised lands. Sadly this trend continues today also, at the cost of local skills and resources.

We are informed that by 1850, the problem of tropical deforestation was already being conceived of as a problem existing on a global scale and as a phenomenon demanding urgent and concerted state intervention. The author acknowledges the fact that scientists and environmentalists once again have the upper hand in state and international environmental policy.

It is an excellent work of painstaking documentation and exhaustive cross references, of human involvement with environmental issues through the millenia. Highly recommended for all students of Natural History, environmental managers and policy makers.

S. ASAD AKHTAR

3. THE END OF A TRAIL. By Divyabhanusinh Chavda. pp. xxii + 248 (24 x 18.5 cm), with many coloured and black and white photographs & line drawings. New Delhi, 1995. Banyan Books. Price Rs. 750/-

In India the study of wildlife has a singular blessing, the dedicated, motivated and talented amateur. Traditionally the amateur has contributed a sizeable share to our knowledge of the country's wildlife. In Divyabhanusinh a hotelier by profession and a committed conservationist by inclination, the Indian cheetah, the little known and enigmatic species of the Indian plains has found a remarkably talented chronicler of its history.

In the eleven chapters of this meticulously researched book, the author leads us on the trail of the cheetah from its origin, its involvement with man and its final extinction in the remote forests of the Surguja district of Madhya Pradesh. Widely distributed in the past in the plains of the African and Indian continents, the cheetah occupied a somewhat narrow environmental niche as a fleetfooted hunter, built for a sudden incomparably high burst of speed which brought it hunting success and finally spelt its doom on the plains of India.

After a brief review of the differences between the leopard and the cheetah which are often confused in their identification, the author turns to his main theme, the association of the cheetah with man as a hunting partner. In the remote past the Egyptians at the time of the Pharoahs had tamed them or atleast the Pharoahs had received them as gifts. Whether the cheetah had been trained for hunting at that point of time in India is not known. We did not have a comparable civilisation with written and visual records. However, the capture and training of the cheetah is probably an ancient art in India as tribals such as the Cheetahwala Pardhis are probably the remnants of our ancient past who have with commendable stubborness kept out of the changing mainstream of Indian life. Though coursing with cheetahs was in practice with the Hindu kings before the advent of the Mohammedans, it was under the Moghuls that it flourished and attained its zenith.

In chapters 3 and 4, Divyabhanusinh gives a well researched review of the status of the cheetah as a hunting tool of the kings of India, particularly the Imperial Moghuls based on the memoirs they wrote and the miniature paintings they had caused to be executed to record the life of their times.

What emerges is the history of the life of the cheetah, its habits, distribution and abundance in the 16th and 17th Centuries. At the peak of the Moghul presence in India, the Emperor Akbar had a menagerie of a thousand cheetahs and is believed to have had 9000 cheetahs during his lifetime. The large number taken into captivity, says the author, was perhaps one of the main causes of the decline of the cheetah. There was a constant and heavy drain from the wild of a species which apparently refused to breed in captivity. It must be noted that the cheetah has now been successfully bred in captivity and could have been bred in captivity in the past as available literature indicates that the techniques were known. It was, however, easier to capture them from the wild and train them to course the Antelope.

The Mohguls, says the author, "turned the coursing with cheetahs into a peerless spectacle". The Emperor Jehangir, for instance, coursing with cheetahs caught 426 Antelopes in a period of 12 days in the Palam area of Delhi where Jet planes take off now on National and International flights! An elaborate organisation had been developed to keep the Empire supplied with Cheetahs and the Empires' demands took a heavy toll on the wild population, a toll which was continued by the Maharajas and other potentates with the eclipse of the Moghul Empire. The decline was further accelerated not only by suitable habitats going under the plough but also by the senseless slaughter by the British who now appeared on the scene. It is difficult to comprehend how the killing of a harmless and beautiful predator can be considered sport. Surely there was something savage and murderous in the psyche of the British of those days who could write with pleasure of the slaughter of six cheetahs at a time! By the turn of the present Century the cheetah was on its last leg and after independence coursing with the cheetah, which was now dependent on animals imported from Africa, disappeared with the Maharajas. It is a pity that the species which was part of a sport of kings was finally extinguished by a Raja in the remote forests of the Surguja District of Madhya Pradesh.

A chapter is devoted to the now defunct art of capture, training and hunting with cheetahs. As in the domestication of any wild animal, the training of the cheetah ultimately amounts to the breaking of its spirit, the so called wildness of the animal. In the case of the cheetah also it is through coercion, starvation and finally a tenous attachment to its keeper and reactions which are a conditioned reflexes. Yet with all its training the cheetah remains remote and withdrawn- a robot ruled by its keeper that looks through you into the far distance. If you are of a sentimental nature the cheetah's far away look is an expression of its yearning for freedom. A more prosaic explanation would be that the cheetah habitually looks out for its prey in the far distance and ignores nearby distractions!

The final chapters consider the cheetah in Africa and Asia and the present status of the species in Asia where a few animals still probably exist in Iran and the possibilities of reintroduction into India. To me, having personally, seen the remote forests of Surguja district where the Cheetah was last sighted by reliable people, there is a flickering hope that the cheetah is still extant in India and deserves a determined search.

This excellently produced book is the last word on the Indian Cheetah and the author and the Publishers are to be congratulated.

J.C. DANIEL

MISCELLANEOUS NOTES

1. FIRST RECORD OF COMMENSALISM IN THE GOLDEN LANGUR *PRESBYTIS GEEI* KHAJURIA AT A NEW LOCATION IN ASSAM

The Golden Langur (*Presbytis geei* Khajuria) is described from the six type specimens collected by H. Khajuria of the Zoological Survey of India in 1955. It has been named *Presbytis geei* in honour of E.P. Gee, India's pioneer wildlifer and the person responsible for bringing the new primate to public attention. The monkey was reported by E.O. Shebbeare in 1907 and later by C.G. Baron in 1947 (Gee 1964). Both these records were near Jamduar on the Sankosh river in Assam. In 1953, Gee was able to see two troops of about 55 individuals at Jamduar and on a later expedition in 1959-60 on west bank of the Manas river, six more troops were seen. Based on these he recommended to the Zoological Survey of India to send a team to collect type specimens and also estimated a total of about 550 individuals to exist between the Sankosh and Manas rivers in Assam (Gee 1964). A number of other scientists have also confirmed the limits of the distribution of the species to be the two rivers and the species is not known to extend either west of the River Sankosh or east of the River Manas (Oboussier and Maydell 1959, Wayre 1968, Roonwal and Mohnot 1977, Prater 1980 and Tikader 1983). The species also extends to south-central Bhutan up to an altitude of 2400 m (Roonwal and Mohnot 1977). Gee (1968) records the species to be timid and never raiding crops as the rhesus does (which is sympatric in some localities), while Roonwal and Mohnot (1977) record it as being shy, avoiding man and almost exclusively a forest dwelling langur. In brief, the species which was the most important primatological discovery of the sub-continent in this century was known only from a narrow strip of mixed deciduous forests bound by the rivers Manas and Sankosh and was known to avoid all contact with man.

On 21.5.95, I accompanied an Assamese friend of mine, Kamini Barua to visit the Umanando Temple, a 200 year old Ahom temple located on a small island just off the coast of Guwahati, the capital of Assam. The island or 'chapori' is a riverine creation of the Brahmaputra which regularly creates and destroys river islands every year. The island is known basically for the temple and I was also told that I could photograph Hanuman langurs (*Presbytis entellus*) there. As the distribution of the hanuman langur in Assam is rather patchy, it was an interesting species to document. However on arrival at the temple I saw four light golden to creamy white langurs on a mango (*Mangifera indica*) tree. As this was more than a hundred kilometres further east than the recorded range of the golden langur, I closely studied the group for more than half an hour. Then upon advice from the local temple priests and my friend I bought 6 Rupees worth of bananas from a local stall and called the langurs as is usually done in the case of the rhesus (*Macaca mulatta*) and the common langur (*Presbytis entellus*) in Hindu temples. Within a few minutes, the adult male responded and came to feed within touching distance. Soon he was joined by a juvenile male as well. The adult female with a smaller juvenile (sex undetermined) remained on top of the tree and did not come down. Both the males however displayed absolutely no fear of human beings and accepted the bananas readily from the hand as well.

Upon enquiry from the local priests, it was learnt that two adult golden langurs were brought to the island two years ago (in 1993) by Bihari devotees. The source of the monkeys was believed to be somewhere in Bhutan which corresponds with the original range of the golden langur. The monkeys have bred in the new location and the two offspring, are a result of that. However apart from the offerings of the pious, these monkeys live a wild existence and do not permit themselves to be handled. This is the first record of a temple golden langur which is hitherto not known to be a commensal species.

During the hour's observations, the monkeys displayed all activities of a normal wild primate including grooming, feeding, foraging and play.

There was no threat or aggressive display however and all four displayed a very gentle and calm temperament. Apart from its interesting commensalism, the occurrence of the species in the wild for the first time outside the Manas-Sankosh complex may be noted, although the species has been helped by man into its new habitat. The breeding success of the primates in Umananda may indicate the start of a new colony near the south bank of the Brahmaputra.

August 26, 1995

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2. OBSERVATION ON AN UNUSUAL SEXUAL BEHAVIOUR IN ASIATIC LION (*PANTHERA LEO PERSICA*)

I chanced to see an unusual sexual behaviour in a male Gir Lion. On 2nd February, 1988 when I was visiting Amritval Settlement area with a group of other officers, a mating pair was observed at Dhanatal area. I returned alone, a few hours later, to observe them more critically.

When the male was ready to copulate, he got up and walked to the female and mounted her. It was obvious that the female was non-receptive. The lioness kept sitting on its belly, tail flat on the ground, and not in the usual receptive posture, for copulation. The male mounted almost half way, over her back. After this, the male kept rubbing his penis on the female's back for 10 to 15 seconds. Having done so the male got up quickly and ejaculated on the ground, very close to the female. This he did a couple of times.

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3. JACKAL (*CANIS AUREUS*) HUNTING COMMON LANGUR (*PRESBYTIS ENTELLUS*) IN KANHA NATIONAL PARK

The Jackal *Canis aureus* has been considered to live mainly on carrion or on small prey in the Indian jungles. I have witnessed in Kanha National Park, Madhya Pradesh (22° 17'N, 80° 38 'E) in the last few years its skills as a hunter. I feel they are worth recording and I do not think that hunting of common langur *Presbytis entellus* by the jackal *Canis aureus* has ever been reported from India.

I first saw a jackal killing a langur in February, 1991 in Kanha meadows and I thought it was a stray case, but since then I have recorded four cases of langur hunting by jackals. The common langur *Presbytis entellus* is an intelligent animal and to hunt them a predator needs great skill and stealth which the jackals of Kanha seem to have mastered over the years. The operation of hunting langurs usually involves a small pack of jackals consisting of three to five individuals which would locate a troop of langurs in the meadows frolicking and running around seemingly relaxed. The pack would slowly approach the troop of langurs and then lying in a small circle with their bellies to the earth, muzzles pointed towards the troop, would identify a langur sitting on the ground far away from a tree. Then one or two of the jackals would run towards the langur at great speed and before the langur can react to reach the safety of a tree would leap at its throat and bring the animal down. Usually the prey is a subadult langur and the adults of the langur troop do try to put up some resistance by slapping the jackal with their palms or by trying to bite. Soon other jackals of the pack converge on the scene of action and the langurs finally give up.

In the last few years the jackal population in Kanha National park has gone up considerably and now it is emerging as a potential predator. Hunting in small packs, the jackals are often seen pulling down fawns of Chital *Axix axis* and are even responsible for high fawn predation in the Hard-ground Barasingha *Cervus duvauceli branderi* of Kanha National Park.

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4. RAT KILLING BY A JACKAL (*CANIS AUREUS*)

There is a small village, Veesma, about 60 Km from Udaipur City, Rajasthan. Uncultivable enclosed land is called Beed in Mewar. On 13th June, 1995, I was crossing a Beed near this village when I spotted a Jackal at 6.10 p.m. I was near a Babool tree (*Acacia nilotica*). Slowly I crouched behind the tree to observe the Jackal. There was scanty vegetation in this Beed. Apart from seven Babool trees, there were a few bushes mostly of *Zizyphus* species.

The Jackal slowly and cautiously moved diagonally away from me. It stopped near a very small bush about 50 m from me. Some excavated fresh soil was visible from my position and I guessed that it might have been a burrow of some rat.

The Jackal started moving around the bush in a haphazard way sniffing the ground. After 10 minutes of this reconnaissance it stopped near the excavated mound of earth and urinated there. Suddenly it dashed towards my tree. As I followed its movements, I saw that there was a burrow in between two bushes about 30 m from me and from this burrow two pups of the Jackal emerged. The female Jackal rushed towards them and pushed them back into the burrow. Again she went to the place and started excavating the earth beyond the small bush. After excavating the earth it again refilled it with her hind legs. In this way she dug the earth at five different places near the bush and refilled them. After a pause of 3 minutes she moved to the place where she had urinated and started digging the earth frantically. After some time she disappeared into the burrow.

After some time she emerged from the burrow, hind quaters first, with something in its mouth and moved towards the burrow where its pups were. I could make out that it was carrying a dead rat and from coloration I can reasonably say that it was a Metad (*Millardia meltada*). It entered its own burrow again, emerged from it and moved towards the freshly excavated burrow and picked up another rat. In this fashion it removed three rats and two young ones and deposited them in its burrow or fed them to its pups.

I came out of hiding and examined the area well. The Jackal had ascertained the most often used hole of the rat colony. It blocked the hole by urinating over it. Apparently smell of fresh urine of the Jackal kept the rats from using this hole for escape. The Jackal found out the alternate holes of escape and after excavating partially and refilling them, the Jackal plugged all the escape routes. It then excavated the main entrance, reached the chamber and killed the rats. The whole episode took 43 minutes.

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5. COMPARISON OF SUSTAINED AND WEEKLY BAITING IN FIELD RODENTS OF JAIPUR REGION

There is an increasing awareness all over the world of economic significance of vertebrate pests, especially rodents. Anticoagulant rodenticides have been evaluated in the Indian subcontinent and some of them were found to be effective, Mathur and Prakash (1980). The present study is conducted to evaluate the weekly and sustained baiting of two anticoagulants, warfarin (0.025% concentration) and bromadiolone (0.005% concentration) in field conditions.

Materials and Methods

The field trial was conducted at village Muhana, 22 km away from Jaipur city. Treatment was carried out in ten different plots, approximately 2.2 hectares each. The pre-treatment level of rodent infestation was estimated by adopting the burrow count method, Barnett and Prakash (1975). The burrows were located, checked for occupancy and plugged with wet soil and lime in experimental plots. The reopened burrows on the next day were treated with 20 gm of poison bait. Sustained baiting with warfarin wax cakes of 0.025% concentration in four plots and weekly baiting with bromadiolone wax cakes of 0.005% concentration, being placed deep inside the burrows in rest of the four plots. Two untreated plots served as the control. Baiting started within fifteen days of planting until the crop was twelve week old. After treatment, burrows were closed and marked. The experimental plots were kept under strict vigil and visited thrice a week. The efficacy of rodenticides was evaluated on the basis of burrow reduction in each plot.

Results and Discussion

Control obtained with bromadiolone (0.005 per cent wax cakes) was 90 per cent as compared to 83 per cent with warfarin (0.025% wax cakes) Tables 1 and 2. Marsh *et al.* (1980) in field trials against the three commensal rodents reported bromadiolone to be highly potent and with a high degree of palatability. Redfern and Gill (1980) reported cent per cent mortality with bromadiolone after three days of feeding against rats and mice.

Table 1

SUSTAINED BAITING WITH WARFARIN (0.025% WAX CAKES)

Plot	Pre-treatment live burrow count	Reduction in live burrows	Reduction in in live burrows (%)	Success over control (%)
A	164	24	85.36	83.48
B	175	23	86.85	84.97
C	182	26	85.71	83.83
D	194	28	85.56	83.68
Control	170	167	1.88	—

Table 2

WEEKLY BAITING WITH BROMADIOLONE (0.005% WAX CAKES)

Plot	Pre-treatment live burrow count	Reduction in live burrows	Reduction in in live burrows (%)	Success over control (%)
A	154	13	91.55	89.05
B	140	10	92.85	90.35
C	145	11	92.41	89.91
D	138	09	93.47	90.97
Control	160	156	2.5	—

Warfarin requires considerably longer feeding period to be effective. Similar results have been obtained for *T. indica* and *M. hurrianae* which were less susceptible to warfarin than *R. norvegicus*, Bentley and Larthe (1959), *B. bengalensis*, Brooks *et al.* (1980).

From the results it can be concluded that sustained baiting requires excess amount of bait which is not economical and involves much labour, whereas weekly baiting is more effective as it gives maximum control success with less quantity of poison bait. The studies further indicate that weekly baiting reduces cost and reduces possible risks to non-target species which is an important factor. The observations also show that when both the poison warfarin and bromadiolone are used in the field, as wax cake formulations, bromadiolone was more effective compared to warfarin.

October 27, 1995

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6. LABORATORY EVALUATION OF CHOLECALCIFEROL AGAINST *MUS MUSCULUS* (BLYTH)

Introduction

Rodents are one of the major vertebrate pests causing considerable damage to crops, stores, godowns and other articles of human value. At present there is a diverse selection of excellent rodenticides available for rodent control. Cholecalciferol is both a single and multiple feeding toxicant effective on *Mus musculus, Rattus rattus* and *Rattus norvegicus* (Marshall 1984). Cholecalciferol (vit. D_3) is closely related with calciferol (vit. D_2). The efficacy of calciferol against warfarin resistant and non-resistant rats and mice were reported by Renninson (1974), Rowe *et al.* (1974) and Muktha Bai *et al.* (1978). In the present investigation the toxicity and palatability of cholecalciferol (vit. D_3) were evaluated against *Mus musculus* (Blyth) in choice feeding test.

Material and Methods

Choice feeding test was carried out in the laboratory against *Mus nusculus* (Blyth). Prior to the experimentation, animals were acclimatized for 15 days. They were fed on mice feed (Brooke Bond Lipton India Ltd.) and water *ad libitum.* Thirty Six healthy individually caged animals were weighed and sexed (18 Males and 18 Females). After 24 hr of starvation they were exposed to poison and plain baits. The poison baits were prepared in broken bajra *(P. typhoides)* mixed with 3% til oil (*Sesamum indicum*). The plain baits contained broken bajra mixed with 3% til oil only. The period of exposure was 24 hr only. The left over and spilled food were weighed the next day. After exposure the animals were kept on mice feed and water *ad libitum.* The observations were made up to 15 days.

Table 1

Toxicity of Cholecalciferol (Vit. D_3) against *Mus musculus* (Blyth) [Choice feeding test]

Conc. of VIT. D_3 %	Exposure Period Hr	Weight of Mice (Blyth) Mean ± S.E. [g]	Bait consumption [g/kg.b.wt.] Mean ± S.E.		Active Ingredient mg/kg.b.wt. Mean ± S.E.	% mortality	Days to Death	
			Plain Bait	Poison Bait			Mean	Range
0.075	24	31.4±4.2	103.5±4.1	91.29±6.0	68.4±2.28	100	4.15	2.9-5.4
0.05	24	33.0±3.9	101.7±4.3	94.22±4.3	47.0±2.4	100	4.59	3.0-6.19
0.025	24	30.6±4.4	100.35±6.0	97.14±6.6	24.03±2.4	50	11.00	7.0-15

RESULTS AND DISCUSSION

The results of the investigation are summarized in the Table 1. Since non-significant ($P > 0.05$) sex difference in mortality was found, hence mortality data for both sexes was combined for analysis. The observations evidently indicate that cholecalciferol gives good results against *Mus musculus* (Blyth). It further indicated that the lower concentration 0.025% of cholecalciferol yielded 50% kill in the range of 7-15 days, where as both the higher concentrations (0.075 and 0.05%) resulted in cent per cent mortality in the range of 2.9-5.4 and 3-6.19 days respectively. The consumption of poison bait reveals its good acceptability and palatability. Poisoning symptoms were noticed after 48 hr exposure which involve sluggishness, crawling movement, pulmonary distress and loss in body weight. Field studies have also revealed that cholecalciferol (vit. D_3) gives 94.44% control success, Saxena *et al.* (1988).

It is evident from the above finding that both the higher concentrations, namely 0.075 and 0.05% of cholecalciferol are quite effective against *Mus musculus* (Byth) and its use on large scale will be boon for the farmers.

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7. ABOUT *DILLENIA AUREA* AND FEEDING BEHAVIOUR OF ELEPHANTS

I studied the Ecology of elephants of Dalma Wildlife Sanctuary for four years between 1989 to 1992. Dalma is situated on the Chhotanagpur Plateau of south Bihar. The essential feature in the physical aspect of the elephants' habitats in south Bihar, is the prevalence of plateaux and hills, often rising into mountains which rarely exceed 1000 m in elevation. The forest of Dalma belongs to a unique *Shorea-Cleistanthus-Croton* series (Gadgil and Meher-Homji 1986). The Champion and Seth (1968) classification shows the forest as consisting of dry peninsular hill sal (*Shorea robusta*), and northern mixed dry deciduous type. The forests of the Chhotanagpur plateau exhibit a variety of habitat types ranging from dry deciduous to evergreen though the study area constituted only dry deciduous type of forest.

Dillenia aurea is also found in the forest along with *Dillenia pentagyna* — the more common associate of sal (*Shorea robusta*) in other places. H.H. Haines in his two classics on the flora of this region, namely Forest Flora of Chhotanagpur (1910) and The Botany of Bihar and Orissa (1925), while describing *Dillenia aurea* writes "Fruit edible and is greedily eaten by wild elephants, which destroy the trees to obtain them." I monitored this species with special interest and found that elephants fed on the bark of this tree albeit rarely. Surprisingly, they neither touched the fruits nor destroyed the trees. This visual observation was substantiated by local tribals who said they had never seen elephants feeding greedily on the fruits of this species but had seen them feeding on the bark of the species on rare occasions. The macro-component analysis of the dung samples never showed remnants of the fruit of *D. aurea.*

Is there a change in the food selection of elephants over a span of 65 years? H.H. Haines never visited Dalma Sanctuary, but his observations were made in other parts of Bihar and in Orissa. The logical explanation to this behaviour could be that the density of this species must have gone low over the years and as a result it was excluded from the dietary of elephants. Presently, this species is common in the Sanctuary and its fruit is relished by the tribals and I enjoyed it equally!

It would be interesting to know whether elephants feed on the bark and the fruit of this tree in other elephant areas.

Incidentally, H.H. Haines quotes Hamilton's observations about the size of the fruit of this species that the fruit was as big as a large-sized apple. Haines notes that he never saw the fruit as large but much smaller. I found that in Dalma Sanctuary and other forests in South Bihar, the fruit is less than half the size of an Apple, golden-yellow in colour, and very sweet when ripe. Thus, my observations support Haines. In that case, in which areas of its distribution, are the apple-sized fruits of *Dillenia aurea* found?

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8. TAXONOMY OF YAK: *BOS* (*POEPHAGUS*) *GRUNNIENS*

Yak, a mammal of economic importance, living at high altitude (3500 - 6000 m above msl) in the Himalayas, Kun Lun, Pamirs, Tien Shan and Altai, has been known as (*Bos grunniens* or *Poephagus grunniens*), for nearly two and half centuries. Its adaptation to life in gelid climates has always drawn considerable interest among naturalists and biologists. Remoteness, inaccessibility of the habitat, political restrictions and religious strictures preventing excavations in the hometract (Palaentological study), had, so far, delayed the establishment of its correct nomenclature. Recently, some studies have been conducted to establish its correct nomenclature and to ascertain the domestication process of yak and to establish its ancestry. Incidentally, the ancestry for most of the other domesticated animals has already been established scientifically. In this communication, an effort is made to record observations on the taxonomy of the yak, made by different scientists.

Linnaeus (1758) named yak as *Bos grunniens.* He included the yak in the cattle group (*Bos*), possibly due to its likeness and nearness to cattle and gave the species name *grunniens,* or the grunting ox. Gmelin in 1760, termed yak as '*Vacca grunniens villora, Cauda equina*' because of its grunting sound and horse like tail. Buffon, another naturalist of the 18th century, contemporary to Gmelin, described in 1767 the yak in a similar manner and called it, a cow of '*Tartary*'. Almost a decade later Pallas, called yak as horsetailed buffalo (Bonnemaire 1984). Smith

(1827) classified the yak as "*B. poephagus* of Aelian, the *B. grunniens* of Pallas." Aelianus Claudius (170-235 A.D.) named yak as *Poephagus* which means grass eater. The observations of Smith were based on physical characters and did not cite any comparison of skull, or skeleton. Incidentally, Linnaeus also did not cite any discussion or comparison of yak before placing it in the genus *Bos*. Jerdon (1836) cited yak as *Bison poephagus* based on its physical appearance on a similar fashion as '*Poephagus* of Aelian and *Bos grunniens* of Pallas.'

The taxonomical names of yak were based mostly on its physical characters and its nearness to *Bos* or to *Bison*. Gray (1843, 1846 and 1852) listed yak as *Poephagus grunniens* after conducting a detailed study of the skull and skeleton. According to him the key difference between the *Bison* and *Bos* were in the formation and placement of the intermaxillaries, which are — "short, triangular, acute behind and not reaching the nasal, being gradually shorter in proportion from *Poephagus* to *Bison*. In *Bos* they are elongated reaching the suture between the nasal and the cheek bone." Lydekker (1898) classified yak as *Bos grunniens* based on the arrangement of premaxillaries, intermaxillaries and nasal bone though he observed yak to be closer to *Bison* than *Bos*. In an earlier work (Lydekker 1876) recorded yak as *Bison* or *Poephagus grunniens*. Jerdon (1874), on the line of Georges Cuvier divided sub-family Bovinae into three groups, the Bisontine (*Bison, Moschatus* and *Poephagus*), the Taurine (*Bos*; hump and humpless cattle and *Gavaeus* flat horn cattle); and Buboline (buffaloes) probably on the observations recorded by Gray and other workers in favour of *Poephagus*. Incidentally reports published in India in 1924 gave yak as *Poephagus grunniens* L., *Bos poephagus* Smith and *Poephagus grunniens* Gray (Annon. 1924). Olsen (1991) also opined, that probably very few, if at all any, skeletal materials were available for the earlier works of the 17th and 18th centuries for detailed comparisons. Olsen (1991) on the basis of observations from 27 skulls in museum collections in the United States, USSR, England and People's Republic of China is in agreement with Allen (1940) who classified yak as *Poephagus grunniens* and further states "the species *grunniens* be re-established in the genus *Poephagus*, rather than be included in the present genus *Bos*".

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9. UNUSUAL CONGREGATION OF NAYAN *OVIS AMMON HODGSONI* BLYTH AT GYAM TSONA, NORTH SIKKIM

The wildlife of the trans-himalayas of north Sikkim is not so well known as the area is 'restricted' and is the boundary between Tibet (China) and India. One of the big animals found here about which not much information is available even in literature is the Nayan or the Great Tibetan Sheep.

On 10th December 1992 while on a winter survey of lakes in this region our jeep was immobilised with high-altitude problems. So I went to the nearest army unit for help. There, after a discussion about the local wildlife, the officer-in-charge rang up various look out points and on locating a herd of 'sheep' over the phone we went to Chhoilung Valley, near the lake Gyam Tsona.

There, spread over the stark, undulating landscape were five groups of a loosely scattered herd of Nayan on either side of the road which was in a sort of shallow valley. One group was to our left and four to our right. The cold-desert topography and elevaion of *c.* 4900-5000 m makes distances very deceptive. The nearest animals were 200-500 m away and the farthest more than a kilometre away.

We counted 94 individuals. This was most unusual as local people reported congregation of not more than 15 and usually 5. Most of them were adult males distinguished by their curving horns and dark head, neck and back. Many were also light coloured with shorter horns obviously females and sub-adults but it was difficult to do a sex count because of the distances and postures of the animals, some of which were grazing and moving away from us and some lying down.

Photographs were taken to record the total number using a 200 mm telephoto lens which was not very adequate. The animals were unafraid of the approaching jeep and not even startled when we got off. The nearest ones moved away only gradually feeding as they went. This behaviour was worth recording keeping in view the general opinion about wild animals in military zones.

I am grateful to Lt. Col. B.B. Singh for assisting me in sighting this unusual congregation.

August 26, 1995

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10. BLACKBUCKS USING THE NILGIRIS EASTERN SLOPES: A CORRIDOR CONNECTING MOYAR VALLEY AND PILLUR SLOPES FORESTS

The Nilgiri hills is flanked by two rivers flowing along the foothills and filling up the Lower Bhavani reservoir to the east of the hills. The river Bhavani originates in the Upper Nilgiris plateau and flows along an east-northeast gradient bordering the eastern slopes of the hills. The north-northeastern slopes are bordered by the Moyar river, which flows through a valley lying between the Nilgiris and Talamalai hills.

The Moyar valley holds a moderately disturbed stretch of forest, contiguous with Sigur Reserve Forest and Mudumalai Wildlife Sanctuary. The major vegetation type of this area is dry deciduous and dry thorn forests. Moyar valley forests form an important corridor facilitating the movement of elephants and other animals between Western Ghats and Biligiri Rangan hills part of Eastern Ghats. These forests also support a population of about 200 Blackbucks, one of the four remaining populations of Blackbuck in Tamil Nadu (Ranjitsinh 1989). This area referred to as Sujjalkuttai forests is proposed to be declared as a wildlife sanctuary (Rodgers and Panwar 1988).There is a narrow stretch of forest along the Nilgiris eastern slopes connecting the Moyar valley forests to the Nellithurai and Pillur slopes forests to south-east of the hills. The Pillur forests are contiguous with Attapadi forests of Kerala thus facilitating the movement of animals further west. There has been reports of elephant movement along the Nilgiris eastern slope corridor between Moyar valley and the Pillur forests.

We have seen a Blackbuck and a doe in the Forest College & Research Institute (FCRI) campus at Mettupalayam in March 1988, recorded for the first time in this area. The animals had moved from the Moyar valley forests to the eastern slopes through the narrow corridor. We had previously seen blackbuck droppings along this corridor, but this was the first time we had sighted the animal. We had also seen wild dogs in the same area. These sightings confirm our supposition that various animals use this corridor. The foothills area bordering the eastern slopes is heavily disturbed by human activities, and this corridor needs to be protected.

October 14, 1995

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11. ALBINO LITTLE GREBE *TACHYBAPTUS RUFICOLLIS*

On 10 November, 1994 I saw in a small road side pond, three Little Grebes (*Tachybaptus ruficollis*), near village Khodri, Bilaspur District of M.P. Amongst them, there was an albino bird which could be distinguished from the others by its unusual coloration.

Occurrence of albinism in this species has not been recorded in available literature.

March 3, 1995

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12. WHITENECKED OR WOOLLY-NECKED STORK *CICONIA EPISCOPUS* (BODDAERT) NESTING ON CLIFFS

The Woolly-necked Stork *Ciconia episcopus* is reported to nest on tall trees (Ali and Ripley 1983, Brown *et al.* 1982, Roberts 1991, Hancock *et al.* 1992). Even in the latest authoritative HANDBOOK (del Hoyo *et al.* 1992) it is mentioned that *C. episcopus* is a "tree nester" (p. 459). However, on 20 October 1994 in the Chambal river near Kota in Rajasthan, we saw from a boat, at a distance of about 15 km, three active nests of Woolly-necked Stork on cliffs on both sides of the river. In two nests, one parent was present, while the third nest had both the parents. We also saw atleast 16 more Woolly-necked Storks in groups of 4, 5 and 7, either flying or sitting on rocks in the river. These storks may also be nesting somewhere. A large number of Indian Longbilled Vultures *Gyps indica,* few Egyptian Vultures *Neophron percnopterus* and a pair of Bonelli's Eagle *Hieraaetus fasciatus* were also nesting on the cliffs along the river.

The Black Stork *Ciconia nigra* also shows two types of nesting sites: in most parts of the Palaearctic region, it nests on tall trees in forests, but in Spain and South Africa, it nests on cliffs (del Hoyo *et al.* 1992). Similarly, the European White Stork *Ciconia ciconia* and the Oriental White Stork *C. boyciana* (earlier considered as the same species) have dissimilar nesting habits. *C. ciconia* invariably nest on buildings, pylons, cliffs and man-made structures, while *C. boyciana* nest on trees. According to Brown *et al.* (1982), the behavioural difference between *ciconia* and *boyciana* is that the former nest on houses, while the later on high trees.

It appears that all the species of *Ciconia* utilizes which ever is the safe site for nesting. Ours is the first record of the Wooly-necked stork nesting on cliffs. Just 300 km north of Kota, in the Keoladeo National Park near Bharatpur, this species nests on trees.

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13. GREYHEADED FISHING EAGLE, *ICHTHYOPHAGA ICHTHYAETUS ICHTHYAETUS* (HORSFIELD) FEEDING ON TURTLE

On 29 December 1994 while observing the Blacknecked stork (*Ephippiorhynchus asiaticus*) in Bankitaal of Dudwa National Park at about 1400 hr, I saw a Greyheaded Fishing Eagle (*Ichthyophaga ichthyaetus*) feeding on something on the ground fully covered by Wild-rice (*Oryza* sp). I could not properly see what it was feeding on except some red coloured material which might have been the intestine. The eagle was constantly pulling it from right to left. Later, I found that it was a turtle.

When I approached in order to collect the half-eaten turtle, the eagle flew away carrying the turtle to a nearby tree.

According to Ali & Ripley (1983), the food of Greyheaded Fishing Eagle mainly consists of fish (exclusively) and rarely will it go for Junglefowl and smaller mammals like squirrels. Lowther (1949) reported that he saw 5 turtle shells in the nest of Pallas's Fish Eagle, *Haliaeetus leucoryphus* (Pallas), while he was photographing the nest. The Greyheaded Fishing Eagle feeding on turtle is a new record.

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14. CUCKOO (*CUCULUS CANORUS* LINN.) IN SIDHI DISTRICT, MADHYA PRADESH, INDIA

During my period of posting in Sidhi District (Vindhya Pradesh Region) of Madhya Pradesh, some interesting variations in the diet, feeding methods and, observations on the possible breeding of the Cuckoo (*Cuculus canorus*) in that region were noticed, and are described below.

The species was sighted from May to October. The birds were seen singly, in twos and occasionally in scattered flocks of 4 to 5 birds (24 and 26 June 1993).

Birds were more vocal during morning and evening hours and called sparsely during the day. The calls were made from perches on trees or on telegraph/electric lines and on the wing. The birds kept their wings drooping, tails partly cocked up when calling from a perch.

The longest duration of call recorded, was by a bird perched close-by, on a tree, for about 28 minutes (24 June, 1993) with three short intermissions of about 1½-2 minutes each at regular intervals. Calls were mostly heard between June to end of July. Birds sighted in some locality in early August and later, were usually silent.

Addition in Dietery and Variation in Feeding Pattern: Some variations to the diet and feeding pattern as mentioned in the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali and Ripley 1987, Compact Edition, pp. 231) and THE FAUNA OF BRITISH INDIA by Stuart Baker, Vol. IV, pp. 136, Ed. 1927) were observed. The species was observed hawking winged termites on 4-5 July, 1993 in the manner of flycatchers on more than two occasions. A bird perched on an electric line, passing over a field pounced on and captured a lizard about 10 cm long in its bill and carried it to nearby tree. On another occasion a bird descended on a ploughed field, probed for food, hopped around in the manner of crow pheasants (*Centropus sinensis*).

The presence of the bird caused alarm amongst such species, as Large Grey Babblers (*Turdoides malcolmi*) and Rufousbacked shrikes (*Lanius schach*) both known as fosterer for the species (Stuart Baker, Vol. IV, p. 136) and confirmed breeders in that locality. On several occasions, they were observed harassing and driving away cuckoos. Other known foster birds, e.g. Reed Warblers (*Acrocephalus*, sp.) Chats other than Brown Rock Chat (*Cercomela fusca*), were more or less absent.

The breeding behaviour of male birds such as courtship chase of females while calling on the wing was observed several times.

The species is known to breed in the hilly regions of Central India (Stuart Baker, Vol. IV, p. 136) and recorded at Sagar, Mhow and Kamptee. The behaviour of cuckoos and reaction of possible foster species suggests breeding of the species in Sidhi District also.

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15. RANGE EXTENSION OF THE MALABAR WHISTLING THRUSH, *MYIOPHONUS HORSFIELDII* (VIGORS)

The distribution range of the species extends in the East to Chhotanagpur (Sarguja) and further to Sundergarh district (Orissa). It inhabits hill streams in dry season, but spreads into the foothills and adjacent plains in rains. The bird is also to be seen sometimes on forest paths, in gardens and compounds, (HANDBOOK Ali & Ripley, p. 598).

During my posting at Sidhi (M.P.) which has predominantly forested hilly terrain, interspersed with plains and plenty of ravines, a bird was sighted at village Karondiya on 15.10.91, around 0900 hr. perched atop a fence post, in an undulating field, adjacent to a nallah. The size of the bird and plumage coloration matched the illustration available, thereby confirming its identification. Later, the bird moved to a nearby post, stayed for there for few seconds and then flew away.

The sighting of the species suggests extension in its distribution range up to Sidhi District also, which has suitable habitats.

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16. NESTS OF THICKBILLED FLOWERPECKER

In his "BIRDS OF KERALA", Dr. Sálim Ali mentions that there is no specific nesting data on the Thickbilled Flowerpecker (*Dicaeum agile*) in Kerala. This species is common in the Peechi-Vazhani Wildlife Sanctuary (Trichur district) and I had the opportunity to locate five nests of this species.

The nests were seen between the months December to March. The majority (four out of five) of the nests were seen in the months of February to March. One nest, that was first seen under construction on 31 December 1991 had a young one sitting outside it on 1 February 1992, suggesting that the period of incubation and fledging is less than a month.

The nests were pouch-shaped and suspended from thin branches or twigs. They were constructed with vegetable matters (fibres) and were well camouflaged.

One of the nests was at an height of 2 m from the ground, on a bush while an exceptional nest was about 18 m from the ground, on a *Terminalia* tree. Three others were placed at heights ranging from 3.5-11 m the known range, according to the HANDBOOK. The nests were located in fairly disturbed forests and in Teak-Bombax plantations.

ACKNOWLEDGEMENT

These observations were made during the course of my research on the ecology of woodpeckers, supported by WCS/The New York Zoological Society, NY, U.S.A.

January 24, 1995

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17. SEASONAL MOVEMENTS IN SMALL SUNBIRD (*NECTARINIA MINIMA*) AND EMERALD DOVE (*CHALCOPHAPS INDICA*)

The lower altitudes of the Peechi-Vazhani Wildlife Sanctuary (Trichur district, Kerala) have four species of sunbirds — Purple (*Nectarinia asiatica*), Purplerumped (*N. zeylonica*), Maroonbreasted (*N. lotenia*), Small (*N. minima*) and the Little Spiderhunter (*Arachnothera longirostris*). Of these, all but the Small Sunbird are permanent residents though the Spiderhunter is the least common and patchily distributed. The sightings of the Small Sunbirds at Peechi (foothills) suggested a pattern indicating the bird has regular seasonal movements that are perhaps linked with the rains.

My sightings of the Small Sunbird have been just before and after the southwest monsoon. In the monsoon months of August and September, it is quite common. It can then be seen not only in the forest areas but also in the campuses like the Veterinary College Campus at Mannuthy, on the outskirts of Trichur town. After September, the bird becomes scarce at the foothills of Peechi and gradually disappears. It then makes its appearance again towards the end of the dry season, in early May, after the first few summer showers and a few weeks before the onset of the monsoon (in early June).

Elsewhere, in the upper reaches and stretches bordering the semi-evergreen forest, I have seen the Small Sunbird in February-March, the peak of the dry season. During the months the bird visits the Peechi foothills, it is quite common. Incidentally, in the other months, the Purple and Purplerumped sunbirds are the commonest.

Another bird that appears to show some seasonal movements is the Emerald Dove. It is quite common in the environs of Peechi in the months of August-October. It does not disappear totally in the dry months like the Small Sunbird, though its numbers are definitely lower than during the wet season. I have not seen its nests or any signs of its breeding in my study areas.

Seasonal movements in nectar-and fruit eating birds have been recorded in literature. It may be interesting to investigate such movements in order to understand the habitat requirements of these specialized species for conservation planning.

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18. VARIATIONS IN OLIVEBACKED SUNBIRDS *NECTARINIA JUGULARIS* (LINNAEUS) OF ANDAMAN, CAR, CENTRAL AND GREAT NICOBAR ISLAND

While cataloguing the sunbirds in the BNHS Collection (Catalogue Part 37), I had noticed the differences among birds within the same race of the species *Nectarinia jugularis,* collected from different islands of the Andamans and Nicobars. I critically studied the 32 specimens of *N. jugularis* innumerable times, arranging them island-wise, and each time noticed the variations among them. The 25 subspecies of *N. jugularis,* listed in the checklist of the birds of the world (A complete checklist of the Birds of the World, Richard Howard and Alick Moore 1980, Oxford University Press) are distributed mainly on the islands of south and southeast Asia, from the Andamans, Malaysia, Singapore, Sumatra, Java, Borneo, Philippines, Sula Is., Kei Is., New Guinea to the Solomon Islands east of New Guinea (The Reader's Digest Great World Atlas, 1981, p. 94-95). Out of the 25 subspecies, 3 are in the Indian list, found in the various islands of Andamans and Nicobars.

The 19 islands comprising Nicobars are more widely dispersed than the 204 in Andamans, hence chances of geographic isolation or the formation of races are more in the Nicobars.

Nectarinia jugularis andamanica (Hume)
(Andaman group)

We have specimens both from Andaman (n=6) and Narcondam (n=6), an island 128 km from Andaman towards Tavoi, Myanmar. Narcondam birds are slightly, but consistently larger in their wing and tail measurements: male wing 56-60 mm (53-55 in Andaman birds), tail 33-34 mm (30-31 in Andaman). The pectoral tufts are brighter in the Andaman birds. In the absence of any other major difference, Narcondam birds are grouped with the Andaman birds under the same subspecies.

Nectarinia jugularis klossi (Richmond)
(Great Nicobar)

There are two groups of specimens of this subspecies, one from Campbell Bay in Great Nicobar (n=4) and the other (n=6) from islands to the north, and below Car Nicobar (*proselia*). There is almost no difference in wing and tail sizes between these two groups, but birds from Great Nicobar have a larger bill (20.5 mm) than those from Trinkut and Nancowry (16.5 - 18 mm). The pectoral tufts in the northern birds are almost as bright as those in *proselia,* whereas in the southern Campbell Bay birds, they are duller. With a larger series of birds it may be possible to separate these two groups into races. We do not have access to the topotypes of Baker's *blanfordi* from Kondol Island, which is treated as a synonym of *klossi,* but it is possible that a comparison of skins from Great Nicobar with those from Kondol Island may show reasons for their separation.

Nectarinia jugularis proselia (Oberholser) (Car Nicobar)

They are like *klossi* but definitely with a shorter bill and very distinctly bright orange-yellow pectoral tufts.

Sálim Ali and Ripley (HANDBOOK Vol. 10, pp. 30-33, 1974) have placed the three forms from the Andaman, Car Nicobar and Nicobar Islands as subspecies of *Nectarinia jugularis.* Baker (FAUNA Vol. 3, pp. 401-404, 1926) considered the birds from Andamans (*andamanica*) to be quite different from those in other islands (of the same group) and placed it in a separate species, *Leptocoma flammaxillaris* together with birds from Myanmar (Burma), with whom they have greater affinity, as the nominate race. This is a more correct classification, considering the fact that these birds (Andaman) have a very large bill, the males have a non-breeding (eclipse) plumage (no. 22119 from Wrightmyo in our collection) as in *asiatica*, and a brown band just below the metallic throat and breast of the breeding male. The abdomen is pale yellow, while in others it is very bright yellow. The pectoral tufts are yellow in *andamanica* contrary to the bright orange in the other two subspecies. The forehead is plain light brown whereas it is glossy metallic in *proselia* and *klossi.* The only specimen we have of the *flammaxillaris* is a breeding male from Ingabu, Henzada Dt., Myanmar (Burma), dated 8.1.1931. The bright orange and black breast band has faded into light orange and dark brown. Specimens of *andamanica* resemble this bird in every respect but lack the orange and black (brown) breast band, instead of which there is a brown one. The pectoral tuft is bright orange and yellow in *flammaxillaris* whereas it is yellow, with no orange in *andamanica.* Baker mentions the presence of an eclipse plumage in *flammaxillaris* also.

Speciation is an extremely slow process. According to Mayr (1942, Systematics and the origin of species), birds with their highly uniform internal environment exhibit a minimum of changeability through external causes. The variation of the phenotype in birds is exceedingly narrow. Or it may be that the environment in the different islands are similar and hence the evolution has taken up almost the same pattern, without any drastic difference. Still the difference in the sizes of the bills of the birds from various islands and the small differences in the colour of the pectoral tufts are noteworthy. It was formerly believed that insular forms are invariably smaller than the mainland forms, this is by no means true. The only generalization we can make is that island forms are often different in size from the other population of the species.

I am indebted to Mr Humayun Abdulali for the discussions I had with him and for correcting an earlier manuscript.

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19. SIGHT RECORD OF GREEN MUNIA *AMANDAVA FORMOSA* IN THE DESERT NATIONAL PARK, JAISALMER, RAJASTHAN

The Green Munia *Amandava formosa* (Latham) is a rare endemic species, very locally and unevenly distributed, mainly in Central India from Mount Abu, Gwalior, Jhansi, Surguja south to Mahableshwar, Utnur (Adilabad) and Visakhapatnam Ghats (Ali and Ripley 1983). Stray records are reported from Lucknow (Reid 1881), Bihar and Lahore (Currie 1916a, b). Currie (1916a, b) found a small breeding colony consisting of 4-5 nests in August 1914 in some ornamental trees in the municipal gardens in Lahore, which H. Whistler presumed were escaped cage birds (Roberts 1991). There has been no record since then, so Roberts (1992) has excluded it from the checklist of Pakistan.

On 24 July 1993, I saw an individual sitting on a *Capparis* bush inside Sudasari enclosure in the Desert National Park in Jaisalmer district of Rajasthan. The nearest known area (Mt. Abu) is about 400 km from Sudasari. According to Ali and Ripley (1983), the Green Munia is found in grass and low bushes, tall grasslands, sugarcane fields, and boulder-strewn scrub jungle. The Sudasari enclosure, where we saw one bird, has up to 1 m tall grasses, thanks to good protection during the last 10 years.

Suresh C. Sharma (*in litt.* 1993) has seen it on 29 and 31 March 1991 in the Taal Chapper Wildlife Sanctuary in Churu district of the Thar desert, which is around 400 km northwest of Gwalior district from where this species was reported earlier. Incidentally, during my 6 years of studies on the Great Indian Bustard *Ardeotis nigriceps* and other birds (*see* Rahmani 1991) in the Karera Bustard Sanctuary in Shivpuri district, and extensive surveys of Gwalior and Shivpuri districts, I did not encounter this species anywhere.

What could be the reason for the sighting of this species in two widely separated areas in the Thar desert? Despite its rarity, the Green Munia is caught for pet trade (Rajat Bhargave, pers. comm. 1994). These recent sightings could have been of escaped caged birds. The Taal Chapper Sanctuary adjoins the village of the same name, so Sharma's sightings could have been from escaped birds but Sudasari is very remote and it is about 65 km from Jaisalmer and I have never seen cage birds being sold in Jaisalmer. The monsoon of 1993 was very good, and during our visit in July, the vegetation was lush green, so most likely, these munias spread out in the desert to avail of the temporary abundance of food and shelter.

February 22, 1995

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20. SOME NOTES ON THE BIRDS OF BHUTAN

During my stay in Bhutan from March 1989 till May 1994 I did some birdwatching in my spare time. Most of my observations were in accordance with the information given in the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN by Sálim Ali and S. Dillon Ripley. However, on several occasions I noted differences or additional information. This paper is written in order to share these observations with others. I will also add some notes that need further investigations, e.g. because the subspecies is uncertain. The sequence of the species will be the same as in the HANDBOOK.

1. **Ruddy Shelduck** (*Tadorna ferruginea*): A pair of this species was observed by me on Gagomo Tso near the Yalela (pass) just south-east of Lhingshi, in the north-western part of the country at an altitude of 4600 m, on May 14, 1993. Although I did not observe a nest, local people told me that ducks were breeding at another lake near Lhingshi. The presence of a pair of these ducks on a location similar to their normal breeding grounds suggests that this species could be breeding in Bhutan as well.

2. *Buzzard* species, probably **Upland Buzzard** (*Buteo hemilasius*): Three Buzzards were seen by me on May 12, 1993 in Lhingshi at an altitude of 4100 m. One gave an aerial display with the typical

buzzard-like mewing call. The tails were heavily barred, unlike most of the tails of the Longlegged Buzzards (*Buteo rufinus*) I observed so frequently in Bhutan in winter (I have seen a Longlegged Buzzard in Bhutan in May as well, on May 5, 1989 in Lhuntsi, East Bhutan). The HANDBOOK states that the Upland Buzzard may nest in the higher Himalayas. This observation can support this view.

3. **Hobby** (*Falco subbuteo*): In the summer of 1993, very often I observed a pair of this falcon in the Gidakom valley south of the capital city of Thimpu. One day a nestling was shown to me by children, reported to have fallen out of a nest near the place where I saw the birds regularly. Race uncertain, but probably *F.s. centralasiae.*

4. **East Himalayan Kestrel** (*Falco tinnunculus interstinctus*): The HANDBOOK states that there is only circumstantial evidence of breeding in the Eastern Himalayas. However on the top floor of the house where I lived for 14 months in Lhuntsi, in the eastern part of Bhutan a pair of this bird was reported to have bred for several years. As the house was renovated before I came, the birds did not return the year I lived there, but they were around the whole summer. I also found the rest of their nest under the roof with a mummified full grown nestling.

5. **Tibetan Partridge** (*Perdix hodgsoniae*): This species is not recorded from Bhutan, but I saw a pair on May 10, 1993 near Chomolhari base camp at an altitude of 4100 m. Again a pair was seen by me on May 13, 1993 in Lhingshi (4200 m).

6. **Purple Moorhen** (*Porphyrio porphyrio*): On December 2, 1989 I was called by local people who had caught a rather unusual bird near a small stream in Lhuntsi, East Bhutan, at an altitude of 1400 m. It turned out to be this species. As far as I know this bird has not been reported from this area. The bird was kept in captivity.

7. **Cuckoo** (*Cuculus canorus*): Singing males of this bird were observed yearly in Gidakom valley (2400 m). Probably this concerns subspecies *bakeri.* According to the HANDBOOK, this subspecies is recorded by Ludlow up to 3300 m altitude in summer. In Lhingshi I saw 2 singing males at an altitude of 4100 m, but may be these were birds of subspecies *canorus* which is recorded in adjacent Sikkim up to 4100 m.

8. **Slenderbilled Blacknaped Oriole** (*Oriolus chinensis tenuirostris*): Although reported as a winter visitor from October to March, I observed a male bird in Lhuntsi on April 16, 1989. A singing male was seen by me on May 16, 1992 in Wangdiphodrang in West Bhutan, at an altitude of 1200 m. This last bird could have been a Golden Oriole as well, as I did not have my binoculars with me that time. However the song was clearly different from the song of the Golden Oriole I know so well from Europe. The Golden Oriole is not reported to have bred in Bhutan.

9. **Dark Grey Cuckoo-Shrike** (*Coracina melaschistos melaschistos*): This bird was seen by me on June 7, 1992 in Gidakom valley, at an altitude of 2800 m which is 900 m higher than recorded before in Bhutan.

10. **Tickell's Leaf Warbler** (*Phylloscopus affinis*): On May 14, 1993 I observed several singing male birds of this species in Lhingshi at an altitude of 3900 m. According to the HANDBOOK this bird was not recorded in Bhutan in the breeding season before, although it is recorded in nearby Sikkim.

11. **Blue Rock Thrush** (*Monticola solitarius*): Recorded by me in Lhuntsi, East Bhutan, in April and August 1989.

12. **Beautiful Nuthatch** (*Sitta formosa*): Occurrence in Bhutan is not certain according to the HANDBOOK. I observed 3 birds near Tingtingbi, Shembang district, on January 31, 1992 at an altitude of about 600 m.

13. **Himalayan Blackbreasted Sunbird** (*Aethopyga saturata saturata*): This bird was seen by me several times in winter (February 19, 1994 for instance) in Gidakom valley (alt. 2400 m). The HANDBOOK states that this bird winters in Sikkim below c. 1000 m and in the western Himalayas between 500 and 1500 m.

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21. DISTRIBUTION OF *KACHUGA SMITHII* (GRAY) IN ASSAM

Kachuga smithii has a wide distribution in the northern parts of the Indian sub-continent. In Assam, the species has been recorded from Sibsagar (Choudhury 1990), Manas and Kaziranga National Parks, and Jorhat (Das 1991). It has an oval carapace with a blackish vertebral stripe. I, here report, some more localities where I examined the species.

During August and September, 1990, I examined three specimens of *K. smithii* in Dhakuakhana area of Lakhimpur district. These specimens were captured in the Brahmaputra river near Matmora. After measurement, they were released in the Charikaria river. All were immature and their carapace was olive (greenish-grey). In adults, the prominence of brown colour on carapace is noticeable. Neck striped with alternate greenish and yellow.

Table 1

MEASUREMENTS (IN CM) OF *K. Smithii*

Locality	SCL	CCL	SCW	CCW	SH/CH	PL	Remarks
Matmora	10.7	—	7.6	—	—	—	Live specimen
Matmora	10.5	—	9.0	—	—	—	"
Saikhowaghat	15.0	—	11.0	—	5.9/-	14.4	"
Saikhowaghat	17.3	18.9	12.25	15.8	/4.9	—	Carapace (AUC 24)

SCL = Straight line carapace length; CCL = Curved carapace length; SCW = Straightline carapace width; CCW = Curved carapace width; SH = Shell height; CH = Carapace height; PL = Plastron length.

In March, 1994, I examined a live turtle caught in the Lohit river near Saikhowaghat in Tinsukia district. Also, in April, 1994, I obtained a carapace (my collection number: AUC 24) from the same locality. The most remarkable feature of all the five specimens was lack of spine, not even a weak one, on the carapaces. Das (1991) had mentioned that a weak spine is present in animals from the eastern parts of the range (i.e. Assam), however, he did not mention of any specific example. The blackish vertebral stripe was conspicuously present in all the specimens.

The records near Saikhowaghat in far eastern Assam (95° 40' E) are now the easternmost for the species. Its range has now been extended by about 200 km with Jorhat being the recorded easternmost locality. The Sibsagar specimen (AUC 01), although tentatively identified as *K. smithii*, is a very unusual one with a weak spine, and it appears to me to be somewhat intermediate between *K. smithii* and *K. tentoria*.

The plastron of all the live specimens examined was patterned and hence, they were of the nominate subspecies, *K. smithii smithii*. The measurements are listed in Table 1.

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22. INDIGENOUS METHOD OF TRANSLOCATION OF THE TUCKTOO *GECKO GECKO* LINN. AS PRACTISED IN MIZORAM, INDIA

Tucktoo is the largest among the geckos and the common house gecko of south east Asia, found in India only in Bihar, Bengal, and Assam (Daniel 1983). The lizard has however been observed in the main towns of Mizoram like Aizwal, Champhai, Kolasib, Serchhip, Lunglei, Lawngtlai and Vairangte by us. It is locally known as OK. OK.. as its call appears to sound like that. Literature reveals that none of the Indian lizards including Geckos are poisonous (Daniel 1983, The Book of Indian Reptiles). However, the Mizos believe that the Tucktoo is very poisonous, and allege that its bite as causing death of people in Mizoram. Apart from that it is also believed that the house which harbours a tucktoo, and if it calls OK.. OK.. nine times continuously at a stretch is a lucky house.

Many people dislike the presence of the lizard in houses due to its droppings. Therefore to get rid of these lizards they translocate them without killing, by using tobacco. Some chewing tobacco sold as 'Khaini' and 'Sada' in pan shops is kept as paste or dry at the end of a dry bamboo which is taken towards the mouth of the tucktoo. The tobacco is kept on the bamboo in such a manner that when the bamboo is moved towards the mouth of the Tucktoo, from a distance, it (tucktoo) bites the bamboo and immediately some tobacco goes into its mouth. Within 2 to 5 minutes of this operation, the tobacco exerts its effect and the lizard loses its balance. Its limbs start shivering, lose their coordination and the gecko falls down, it is then caught by hand and placed in a container, where it remains senseless for 20 to 30 minutes. During this period the Geckos are translocated to Forest/Jungle areas in a humane manner without damaging or killing them.

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23. "BATTALION MOVEMENT" IN RECENTLY METAMORPHOSED BICOLOURED FROGS (*RANA CURTIPES*)

While visiting a cardamom plantation in the Coorg Hills on the morning of the 19 March 1994, we observed a curious swarm of bicoloured frogs emerging from a pond. The pond in question is located in a wooded defile and is one of the two which is fed by the Madenad stream on a plantation belonging to Mr. K.M. Chengappa, the junior author's brother-in-law. The plantation is located 8 kilometres from Madikeri. Large swarms of tadpoles were visible in the two ponds and were seen to display the shoaling behaviour characteristic of the species (Daniel and Sekar 1989, *J. Bombay nat. Hist. Soc. 86*: 194-202). On a steep grassy bank we noticed a closely spaced column of frogs emerging from the water and slowly creeping through the vegetation. The movement of the frogs proceeded in a single mass and after one meter, gave way to a side column, which was equally dense in its spacing. After a distance of 1.5 m the individual spacing increased and the frogs began to disperse in diverging directions. The movement of these frogs was distinctively battalion-like and differs from the unsynchronized movement usually seen in recently metamorphosed anurans upon emerging from water. We have not found a descriptionof this movement in the literature, but note that V.S. Vijayan observed (in Daniel and Sekar 1989) that "enormous numbers of the metamorphosed young occur on the banks of the many inlets of the Periyar Lake in the summer months" where they are eaten by wild boar. The tightly packed battalions of these frogs would seem to place them at a disadvantage to predation.

We thank Mr. J.C. Daniel for identifying this distinctive species, based on our description.

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24. ADDITIONS TO THE UPDATED SPECIES LIST OF AMPHIBIAN FAUNA OF INDIA

In 1986 Inger and Dutta reviewed a faunal list of amphibia of India which included 181 species. Chanda and Ghosh (1988), and Das (1990) pointed out the omission of 25 species in that list. Recently, Dutta (1992) presented an updated species list of amphibia, comprising 197 species, with the explanations to the species omitted by Inger and Dutta (1986).

However, two valid species *Ansonia kamblei* Ravichandran and Pillai 1990, collected from Maharashtra and *Micrixalus gadgili* Pillai and Pattabiraman 1990, collected from Kerala were not incorporated in the new updated species list and no explanation was given in the list for the omission of these two species. Therefore, the total number of amphibian species of India is 199 with the addition of these two valid species.

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25. EXTENSION OF RANGE OF DISTRIBUTION OF *HORADANDIA ATUKORALI* DERANIYAGALA (PISCES: CYPRINIDAE: RASBORINAE) TO PONDICHERRY AND TAMIL NADU

Horadandia atukorali Deraniyagala, 1943, was described from the weedy freshwater ponds of the coastal plains of Sri Lanka. It is characterized by the absence of barbels and lateral line and was thought to be endemic to Sri Lanka until 1992, when it was found in the west coastal plains of Kerala, India. Based on differences in body shape, the lateral line scale number and the number of branched dorsal fin rays, the west coast Indian form was described as a new subspecies *H. atukorali brittani* Rema Devi and Menon, 1992. Later it was considered a synonym of *H. atukorali* (Menon 1993). The present record of the species from the freshwater bodies of Kalpakkam and Pondicherry, by scientists of the Southern Regional Station, Zoological Survey of India extends the range of distribution of the species to the eastern coastal plains of India. The report is based on 7 specimens 11-17 mm SL collected during 1992 and 1995 and deposited in the reserve collections of the station.

Horadandia atukorali Deraniyagala

Horadandia atukorali Deraniyagala, 1943, *J. Royal Asiat. Soc.,* Vol. xxxv, 96: 158, 159, fig. 1 (Type locality: Attidiya, Colombo, etc., Ceylon); Munro, 1955, *Marine and Fresh water Fishes of Ceylon*: 41, pl. 17, fig. 107.

Horadandia atukorali brittani Rema Devi and Menon, 1992, *Tropical Fish Hobbyist,* Vol. XL (10): 175-176, figs. 1 & 2, table 1 (Type locality: Pond in Pathiramanal Island, Shertallay, Kerala, India).

Distribution: Sri Lanka. INDIA: Coastal wet zones of Kerala, Tamil Nadu and Pondicherry.

Remarks: From India, *Horadandia atukorali* has so far been reported from the western coastal wet plains, in ponds, ditches and in the Vembanad Lake of Kottayam and Allepey Districts of Kerala (Rema Devi and Menon 1992, Rema Devi *et al.* in press). The present report extends its range of distribution to the eastern coastal wet zones. It was found among weeds, along the littoral regions of the Sankaraparni river, flowing through Villianur in Pondicherry and a freshwater pond in Kalpakkam, Madras. Parental care is lacking in this species (Brittan 1961); and the eggs attached to submerged vegetation and the fry tend to become an easy prey to carnivorous species occurring in the same habitat. Regarding its habitat and utility value, Pethyagoda (1991) writes that it is essentially a still (or slow-moving) water fish, frequenting less saline mangrove swamps and less polluted canals, rice fields and similar still waters. He remarks that it is a useful mosquito larvivore and that its habitat in Muthurajawela swamp (Sri Lanka) is heavily fished for small shrimps (kuni) which are sun-dried and sold and that *Horadandia* forms a noticeable proportion of the kuni. Grows to a length of 25 mm SL.

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26. FRESH WATER FISHES OF PAMBAR RIVER, CHINNAR WILDLIFE SANCTUARY, KERALA

INTRODUCTION

Freshwater fishes of Kerala, especially Travancore region had gained attention of various workers in the past (Day 1878, Pillay 1929, John 1936, Hora and Law 1941, Hora and Nair 1941, Raj 1941 a & b, Silas 1949, 1951 a & b). However, there has been no authentic record of the fish fauna of the region for the last forty years.

The Pambar river and its tributary Chinnar, one of the three east flowing rivers of Kerala, passing through Chinnar Wildlife Sanctuary were surveyed in June, 1995. Chinnar Wildlife Sanctuary, situated in the Idukki district of Kerala is covered mostly with dry deciduous forests. The area is bordered by Indira Gandhi Wildlife Sanctuary of Tamil Nadu and forests of Marayur Range and Eravikulam National Park of Kerala.

METHODS

The river Pambar and the tributary of Chinnar have a width of about 7-10 metres and depth of 1.0-1.5 metres, and the bottom was rocky in most of the areas with intermittent rocky pools. The temperature varied between 22°-24° C and pH was 7.00. The conductivity of water was 280-485 μmhos/cm. Collections were made using cast net, gill net and scoop net. The list of species collected, along with notes on some species of interest is given below.

Family: CYPRINIDAE
Sub-family: CYPRININAE
1. *Puntius carnaticus* (Jerdon)
2. *Tor khudree* (Sykes)
Sub-family: RASBORNINAE
3. *Rasbora daniconius daniconius* (Hamilton)
4. *Barilius bendelisis* (Hamilton-Buchanan)
5. *B. gatensis* (Cuv. & Val.)
Sub-family: CULTIRINAE
6. *Salmostoma acinaces* (Val.)
Sub-family: GARRINAE
7. *Garra gotyla stenorhynchus* (Jerdon)
8. *Garra mullya* (Sykes)
9. *Garra menoni* Remadevi & Indra
Family: HOMALOPTERIDAE
Sub-family: NOEMACHEILINAE
10. *Noemacheilus denisoni denisoni* (Day)
Family: COBITIDAE
Sub-family: COBITINAE
11. *Lepidocephalus thermalis* (Hamilton)

RESULTS AND DISCUSSION

Eleven species of fishes belonging to three families were collected from the area. Most of these are widely distributed throughout Western Ghats. However, of these, *Barilius bendelisis* is a new record from Kerala and *Garra menoni* is the second report of the species from a different location.

Garra menoni was originally reported from Kunthi river in Silent Valley National Park (Remadevi and Indra 1981, 1986). It is rare in Pambar compared to *Garra mullya* and *Garra gotyla stenorhynchus.*

It is different from all other known species. It is close to *Garra hugi* Silas but differ from it in the presence of scales in the mid-dorsal streak. Talwar and Jhingran (1991) synonymised *G. menoni* with *G. mullya* (Sykes) but it differs in the shape of head and snout, absence of scales on chest and belly, and marked position of vent.

Barilius bendelisis (Ham. & Buch.) was considered to be present throughout India except Kerala (Talwar and Jhingran 1991).

Chacko (1948) reported its occurrence in Periyar lake, Thekkady, but later Jayaram (1981), Talwar and Jhingran (1991) and Menon (pers. comm.) considered it as erroneous. The present survey confirms the occurrence of this species in Kerala.

DISCUSSION

Puntius carnaticus (Jerdon) is described so far only from Wynaad (Cauvery river system), Canara and Bhavani river (Day 1878, Rajan 1955). The occurrence of this species in Chinnar shows its extended range. Similarly, *Garra gotyla stenorhynchus* (Jerdon) is reported only from the Cauvery river system. These species indicate faunal similarity between the eastward flowing river systems of Kerala. The presence of *Garra menoni* (Remadevi and Indra), described originally from the west flowing Kunthi river adds further importance to the fish fauna of Chinnar.

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27. OCCURRENCE OF *THOSEA ANDAMANICA* HOLLOWAY (LEPIDOPTERA: LIMACODIDAE) ON COCONUT IN THE NICOBAR ISLANDS, BAY OF BENGAL, INDIAN OCEAN

Seventeen of the 31 species included in the genus *Thosea* are insular endemics, of which *T. andamanica* has one of the most restricted distributions (Holloway *et al.* 1987).

As early as in 1925 outbreaks of *Thosea andamanica* were reported from South Andaman (Isaac 1925), the first of the Andaman group of islands to be colonised by literate man in the late nineteenth century. These outbreaks, between the years 1922-1925 were reported on coconut (*Cocos nucifera* L.). Subsequently, in 1991 (Bhumannavar *et al.* 1991) it was reported as a minor pest of oil palm (*Elaeis guineensis* Jacq.). This was followed by a report in 1992 of an outbreak of the limacodid in a 68 ha coconut plantation in S. Andaman (Ansari *et al.* 1992).

Thosea andamanica has so far not been recorded from the Nicobars (Holloway *et al.* 1987), a group of islands separated from the Andaman islands by the 150 km wide ten degree channel (Snow 1970). For the first time we report the presence of this moth on coconut from the Central and Southern Nicobars in the islands of Katchal and Great Nicobar. The larvae, which were found in large numbers on coconut fronds (2 to 3 larvae per leaflet), were collected by K. Veenakumari from the Nicobar islands during a recent survey for insects in August, 1993. They looked larger and appeared to be different from, the *T. andamanica* larvae collected from the Andaman islands. However, the adults that emerged from these larval rearings were identified as *T. andamanica* by Dr. J. D. Holloway of the International Institute of Entomology, London. *Aphanogmus manilae* (Ashmead) (Hymenoptera: Ceraphronidae) were collected from containers containing dead *T. andamanica* larvae. *Aphanogmus* spp. are known to be hyperparasitoids. And, Isaac (1925) found *Fornicia* sp. parasitising larvae of *T. andamanica* which in turn were in all probability parasitised by what Isaac (1925) tentatively identified as *Aphanogmus* sp.

In the Andamans the hosts of this moth included *Atrabotrys* sp. (Annonaceae) and *Glochidion hirusutum* (Euphorbiaceae) both of which are new host records for the species (cf. host records in Cock *et al.* 1987).

Thosea andamanica has so far been recorded only on coconut and oil palm in the Andaman islands (Isaac 1925, Bhumannavar *et al.* 1991). Both these species were introduced to the Andaman islands for cultivation. While the latter was introduced as recently as in 1975 (Prashanth *et al.*, in press) the former which is native to the Nicobars was introduced to the Andamans by the early British settlers (Temple 1901). Therefore, if coconut is the original host plant of this species, from which it has diversified to include other plants in its diet, then *T. andamanica* must be native to the Nicobar group of islands from where it has extended its range northward to the Andamans.

It is, however, likely that the original food plant of the species was *Areca* (Ansari *et al.* 1992), *Barringtonia* (Holloway *et al.* 1987), *Atrabotrys*, or *G. hirusutum* (cf. above); in which case *T. andamanica* could have spread/dispersed from the Andamans to the Nicobars or vice versa across the ten degree channel. In such a situation *T. andamanica* would be a native of the Andaman and Nicobar archipelago.

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March 14, 1995

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28. STRANGE BEHAVIOUR OF MOTTLED EMIGRANT MALES

It was almost the end of July 1992 and the heavy showers of monsoon had made everything turn lush - green. Walking along the grass, near Malwadi, the western outskirts of Pune, my attention was attracted by two males of the Mottled Emigrant (*Catopsilla pyranthe*). The two males were hovering around a *Lantana* twig. I could see the wings of a female Emigrant on the underside of a leaf. Emigrants generally mate on the ground. The female sits with her wings wide open and projects the abdominal tip outwards. The male lands on her back and clasps her abdomen with the claspers adapted for the purpose. Then he immediately takes off. The female remains suspended.

But on this occasion, the female was sitting on the underside of the leaf and the two males were fluttering around her. On a closer look I realised that the female was dead and a crab spider was clutching her firmly in its legs. These anxious males were probably trying to mate with a dead female. But as she was on the underside of the leaf, they were not able to land on her. Finally they gave up and flew away. A few more males also came later and exhibited similar behaviour.

When I twisted the twig to get a photograph, a male landed on the female and started rubbing his proboscis on her thorax. He was trying to suck something. The spider was trying to push him off the female's body. I could easily document this moment on film. The photograph clearly shows the male sitting on the spider and the dead female, and apparently sucking something from her thorax. The spider also can be seen pushing the male. After a few seconds the male flew away.

The males were probably attracted towards the female and were unable to differentiate between a dead and a live female. The last male, which actually landed on the female's body probably also did not notice the well camouflaged spider. The more surprising facts, however, were that the spider that had just killed a female, did not attempt to kill the male and that the male also was not deterred even after the spider started pushing it off. Finally what was the male sucking from the female's body?

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29. PREVENTION OF RHINOCEROS BEETLE (*ORYCTES RHINOCEROS*) IN COCONUT PALM USING RED ANTS

Rhinoceros beetle (*Oryctes rhinoceros*) has been one of the most important and major pests of coconut palms in almost all coconut growing regions of the World. The adult beetle is stout with dark dorsal surface and reddish - brown ventral surface. It is 35.50 mm in length and 14 - 21 mm in width, and has a slightly tapering horn on its head. The female beetle lays eggs singly in any decaying organic matter in the field. The eggs hatch in 8-14 days and produce larvae. After completing larval and pupation stages adult beetles emerge from the organic matter and then cause severe damages to coconut palms. Besides, it also damages palmyra palm (*Borassus flabellifer*), toddy Palm (*Phoenix sylvestris*), oil palms (*Elaeis quianensis*), aloe, sugarcane, pineapple and screw-pine (Seshagiri Rao 1972). BHC, Oil cakes and Chlordane dust are used for controlling the beetles.

Red ants (*Oecophylla smaragdina* Fb.) has been known for their pest control activity. In Arabia caterpillars and large boring beetles were destroyed in date palms using the red ants in 1775 (Debach 1974). Coconut moth (*Levuana irridenscens)* in Fiji was killed using the red ants (Tothill *et al.* 1930). Citrus shield bugs (*Rhynchocoris* sp.) in citrus farms in China have been killed using the red ants (Hill 1983). This pest eating property is used to prevent rhinoceros beetle in coconut palms.

25 young (5-9 years old) coconut palms severely attacked by rhinoceros beetle were selected in seven plantations in different parts of Kanyakumari District, Tamil Nadu. Red ants were collected along with their nests from *Thespesia populnea* tree and introduced into the crown of the affected coconut palms. Killed insects were added into the crown to feed the ants. After a month the pest damage was tested in the palms. All the test palms were cured by the ants. The young leaves were quite normal and did not have symptoms of the beetle attack. 25 adult beetles were collected from compost pit and introduced into the crown of

palms in which the ants were living. This was done by tying one of the legs of each beetle with a thread. Even if the beetles were introduced into the crown, they tried to fly away from the crown, and did not produce any symptom of the beetle attack. When this was done in antless, five years old, coconut palms 7 beetles escaped from the crown and the remaining 18 beetles made holes in the stalks of young leaves. Thereafter the affected palms were cured by introducing red ants.

Even though rhinoceros beetles have hard skin, red ants tried to catch and eat them when the beetles were introduced into the crown of palms with red ants. The vicious bites and injection of formic acid at sensitive parts of the beetles might be the reason for the control of beetles in ant introduced trees. But red ants have been considered as minor pests for coconut for many years because they cause some difficulties in harvesting (Hill 1983). However they increased yield in coconut palms (Kumaresan 1994).

I thank Prof. R. Bothi, Head of the Department of Botany, Vivekananda College of encouragements and Dr. Dunston P. Ambrose, Entomology Research Unit, St. Xavier's College, Palayamkottai for references and suggestions.

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30. NEW DISTRIBUTIONAL RECORD OF *TRICHOTRIA TETRACTIS* (ROTATORIA/ TRICHOTRIDAE) AND *DAPHNIA LUMHOLTZI* (BRANCHIOPODA/CLADOCERA/ DAPHNIDAE) FROM KOLLERU LAKE, ANDHRA PRADESH WITH NOTES ON INDICATOR VALUE

Ecological studies on Kolleru lake (lat. 16° 32' and 16° 47' N, long. 81° 21' and 81° 51' E), Krishna and West Godavari Districts, Andhra Pradesh have been in progress by the junior author. The rotifer plankter, *Trichotria tetractis* occurred in samples from Kolleti Kota in the eastern flank of the lake, Krishna District, while *Daphnia lumholtzi* was observed in samples from Kovvadi Lanka, in the western flank, West Godavari District.

Despite general status reports (Radhakrishna 1988, Seshavatharam and Dutt 1978, and Rama Murthy 1982) comprehensive systematic studies on the zooplankton component from around the region are few and far between (Reddy 1977, Durga Prasad 1981 and Durga Prasad and Padmavathi 1991).

Trichotria tetractis (Ehrenberg, 1832)

Remarks: Rather uncommon in distribution, it has not been reported/recorded as frequently as other rotifer species. The only earlier reports of this rotifer from Indian plankter are by Arora 1966 (Nagpur), Wulfret 1966 (Baroda), Nayar and Nair 1969 (Kerala) and Dhanapathi 1974 (Bhimavaram, West Godavari Dist., A.P.). Elsewhere, Daems and Dumont (1974) recorded *T. tetractis* from Nepal. Apparently, the rotifer, *Trichotria tetractis* is rare in occurrence and was observed only in samples, from Kolleti kota in the eastern zone. Indian studies recording *Trichotria tetractis* as indicator of water quality are therefore not known. Kuezynski (1987) rates the species as occurring in low II or oligoconductive waters (Conductivity 180 - 500 μ Scms^{-1}). Slâdecek (1983) has assigned this species b-0 saprobic degree, i.e. both beta-beta saprobity and oligosaprobity and further computed its I, (the indicative weight of the species) as 3 and its S_I value (individual saprobic index) as 1.6. In Kolleru lake the ploimate rotifer (*T. tetractis*) occurred in waters with high conductivity (130 mS/m), and relatively higher total alkalinity and total (EDTA) hardness, etc. The reported phosphorus and other heavy metal ion contents for eastern zone are much higher than the western zone. Arora (1966) recorded the species from sewage polluted tanks (Jumma & Sakardara tank, Nagpur), with a BOD value ranging between 35-40 ppm. *T. tetractis* therefore is an indicator of eutrophic conditions.

Daphnia lumholtzi Sars, 1885

Remarks: Despite its cosmopolitan distribution, this species has not been recorded earlier from Kolleru lake. Further, *Daphnia lumholtzi* has also not been documented from other lake ecosystem as well. The only previous record of this daphnid plankter from the state is from Fish ponds in Fish seed farms, A.P. Fisheries, Hyderabad (Michael and Sharma 1988).

We thank the Director, Zoological Survey of India (ZSI), Calcutta and the Officer-in-Charge, ZSI, Fresh water Biological Station, Hyderabad for facilities and encouragement.

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31. REDESCRIPTION OF *MACROCHELES LIMUE* SAMSINAK (ACARINA: MACROCHELIDAE)[1]

(*With fourteen text-figures*)

Introduction

Macrocheles limue was originally described from China by Samsinak (1962). The description was based only on females and the specimens were collected off *Oniticellus cinctus* Fabr. at Canton, China. The species is very common in India and has been collected from diverse habitats. This is a subsequent record of the species from another geographical region since its original description. Male hitherto unknown, is recorded for the first time from India. A redescription of the female is also presented in this paper, as variations have been observed, together with a description of the male.

Except where the name of the collector is mentioned, the material was collected by the author. Measurements given in the text are in micrometres.

Macrocheles limue Samsinak, 1962.

Macrocheles limue Samsinak, 1962. *Cas. csl. spol. entom.* 59: 202-203.

FEMALE: (Figs. 1-6); Dorsal shield (Fig. 1) 810-960 long, 495-570 wide, reticulate, very finely punctate throughout; ornamented with characteristic sclerotized pits in some specimens while absent in most others; with a poorly defined procurved line behind insertions of setae z6 and bearing 28 pairs of setae. Vertical setae, (j1), approximately 60, plumose with their bases closely apposed; j5, z5, j6, z6 short among dorsal setae (approximately 30); z1 pilose distally; j4 smooth, sometimes appearing distally pilose; j5 pectinate throughout; remaining dorsal setae simple. Margin smooth, extramarginal setae simple.

Sternal shield (Fig. 2) punctate-reticulate, posterior margin highly concave; *l.m.t.* well-defined; *l.o.p.* bifurcated in their posterior halves; with a distinct *l.arc.*; *l. ang.* distinctly continuous posteriorly into a weakly sclerotized medial ridge; area of shield anterior to *linea angulata* porose as also the posterior margin; sternal setae fairly long and simple. Metasternal shields triangular adjacent to sternal shield and with a pair of simple setae. Genital shield punctate-reticulate, truncated posteriorly, and with a pair of simple setae. Ventri-anal shield 270-315 long, 315-405 wide, broader than long, somewhat truncated anteriorly, flanked laterally, rounded posteriorly, and ornamented with a series of arched punctate lines forming a network, ventri-anal setae fairly long and smooth. Metapodal shields posterior to coxae IV, elongated and thickly sclerotized. Stigmata laterad of coxae III-IV, peritremes extending laterally and fusing with dorsal shield half way between setal insertions of j1 and z1.

Gnathosoma (Fig. 3) with five rows of deutosternal denticles. Tectum as shown in Fig. 4. Movable digit of chelicera (Fig. 5) with a bicuspid tooth and a distal tooth; fixed digit with small tooth at apex, one large median tooth; dorsal seta thickened and spatulate; cheliceral brush extending almost half the length of movable digit.

Approximate lengths of legs (excluding pretarsi) I-495; II-510; III-465; IV-660; Tarsus I (120-150) longer than tibia I (105-135). Tarsus II (Fig. 6) 120-165; tibia II (75-90). Genu IV with six setae of which is al pilose.

MALE: (Figs. 7-14): Dorsal shield (Fig. 7) 630-690 long, 375-405 wide, punctate-reticulate, posterior margin crenulate beyond setae S4 and bearing 28 pairs of setae. Setae j1, j4, z4, z6 and Z4 distally plumose, j5 smooth or pectinate.

Genital orifice presternal in position. Sternitigenital shield (Fig. 8) 300-315 long, 135-165 wide; punctate-reticulate and with 5 pairs of simple setae. Ventri-anal shield 195-200 long, 210 wide, broader than long, shape of the shield as in female, laterally more sharply flanked with punctate-reticulate

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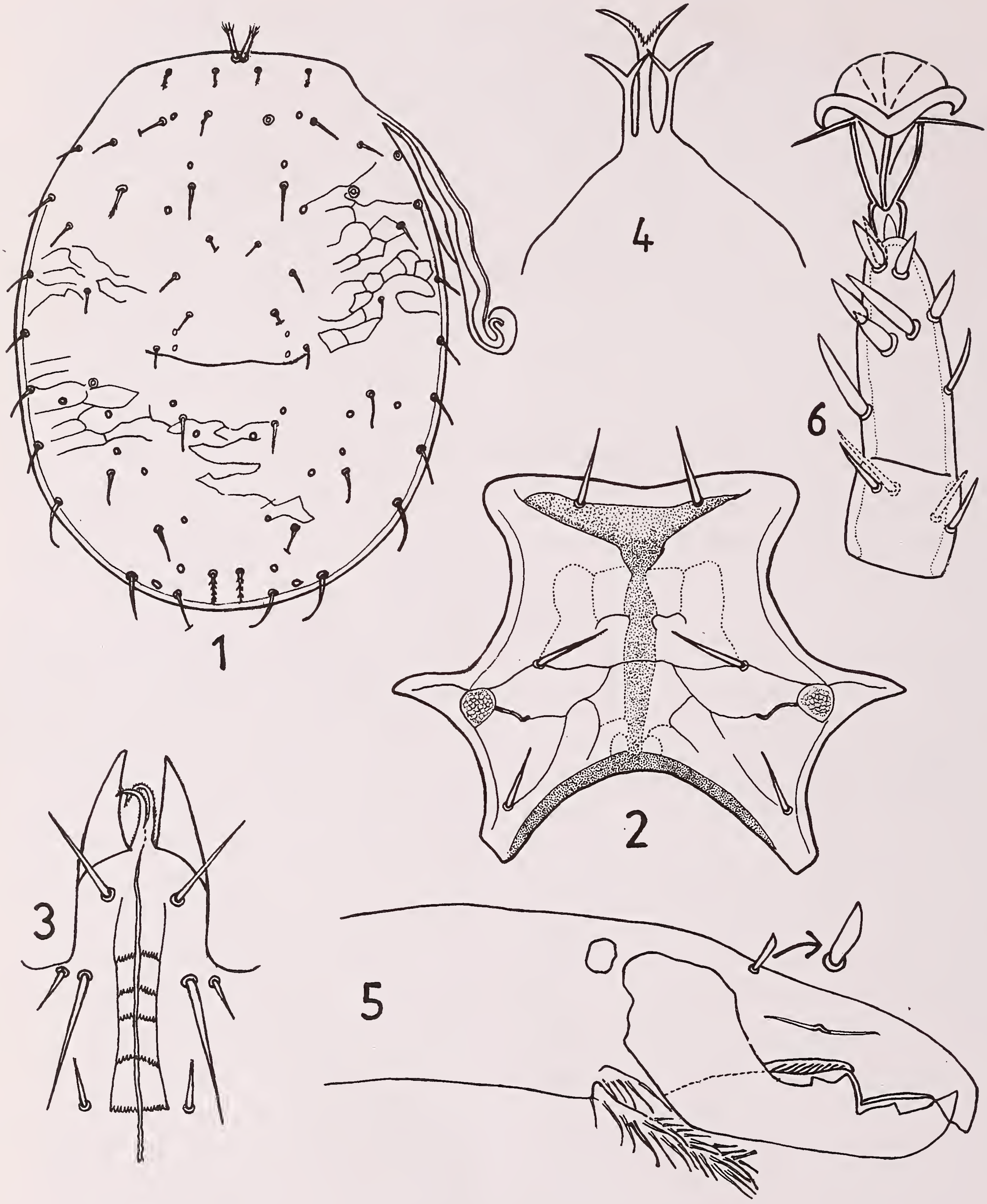
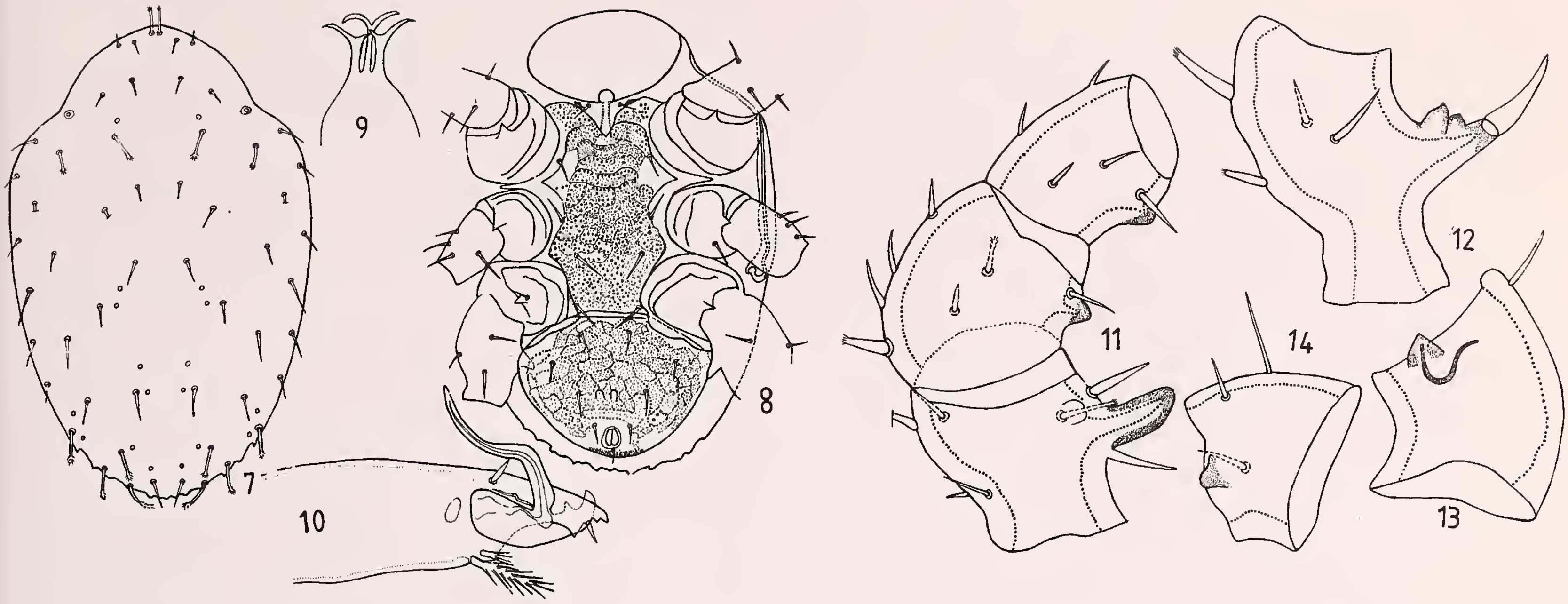
[1] This is the sixth paper in the series ``studies on Indian Macrocheles".



Figs. 1-6. *Macrocheles limue* Samsinak, Female
1. Dorsal shield; 2. Sternal shield; 3. Gnathosoma; 4. Tectum; 5. Chelicera; 6. Tarsus II.



Figs. 7-14: *Macrocheles limue* Samsinak, Male
7. Dorsal shield; 8. Sternitigenital shield; 9. Tectum; 10. Chelicera; 11. Femur II; 12. Femur IV; 13. Genu IV; 14. Tibia IV.

ornamentation and bearing 3 pairs of preanals, a pair of adanal and a postanal setae.

Gnathosoma as in female. Tectum as shown in Fig. 9. Movable digit of chelicera (Fig. 10) with one large tooth and a large spermatophoral process 1½ times as long as digit; fixed digit with 2 small apical teeth and one large median tooth; cheliceral brushes as in female.

Femur II (Fig. 11) laterally with a strong spur apically rounded; genu and tibia II each with a lateral spur. Legs IV show variation in spur development. Femur IV (Fig. 12) spurred; genu IV (Fig. 13) variable either with a spur or small protuberance or without; tibia IV (Fig. 14) with a spur. Genu IV with six setae, plumosity obscured.

Material examined: 2 females, Andhra Pradesh: Waltair, Simachalam Temple premises, 24. iii. 1980, ex soil litter; 1 female, Tirumala Devasthanam, 22. iii. 1980, ex decaying grasses; 2 females, Assam: Dibrugarh, S. Ghosh's Garden, near Brahmaputra bank, 8. iv. 1975, ex garden soil; 13 females, 4 males, Dibrugarh, Gosala, 26. vi. 1979, ex cowdung; 7 females, Dibrugarh, Bishop's Church compound, 6. iv. 1974, ex banana plantation litter; 1 female, Tinsukia District, Ledu, 3. iii. 1974 ex decaying areca nut peelings; 1 female, Tinsukia District, Makum, Orange Garden, 5. v. 1974, ex grassy soil; 3 females, Dibrugarh District, Mohanbari Airport, 30. xii. 1982, ex grassy soil; 3 females, Sibsagar District, Jayasagar, Sibsagar College campus, 3. iv. 1978, ex soil under heap of grasses; 2 females, Jorhat District, Titabar, Sericulture Research Institute campus, 10. v. 1971, ex compost heap; 3 females, Karbi Anglong District, Diphu, 7. iv. 1981, ex cowdung; 1 female, Nowgong District, Lumding, Jholanpul, 3. xii. 1976, ex elephant dung; 1 female, North Cachar Hills District, Hallong 1650 m, lake area, 3. xii. 1974, ex soil litter; 3 females, Cachar District, Badarpur, near Rly. Station, 6. x. 1975, ex dung heap; 3 females, Cachar District, Loharband, 10. xii. 1969, ex *Onitis singhalensis* Lansb.; 2 females, Sonitpur District, Tezpur, near lake area, 2. xi. 1977, ex decaying water hyacinth (*Eichhornia* sp.); 2 females, Bihar, Patna, Rajendra Agricultural University Farm, 27. xii. 1981, ex decaying husks; 2 females, Gujarat: Gir Forest, 6. vi. 1973, ex soil litter; 1 female, Karnataka: Bangalore, ex *Copris* sp.; 2 females, Kerala: Palghat, near Rly. Station, 14. iii. 1980, ex dung heap; 1 female, Walayar Forest, 14. iii. 1980, ex leaf litter; 1 female Maharashtra: Bombay, Colaba, near TIFR, 20. v. 1970, ex compost; 1 female, Pune, near Poonam Restaurant, 1. vi. 1970, ex humus soil; 1 female, Manipur: Moirang, near INA Memorial, ex decaying grasses; 1 female, Meghalaya: Khasi Hills, Ranikar, 16. iii. 1974, ex soil litter; 2 females, Garo Hills, Baghmara, 16. iii. 1974, ex dung heap; 2 females and 2 males, Nagaland: Kohima-1459 m, 25. xii. 1980, ex refuse dump: 2 females, Mokokchung, 25. xii. 1980, ex *Copris* sp.; 2 females, New Delhi; JNU Campus, 2. vii. 1981, ex leaf litter; 2 females, Pondicherry: Botanical Garden, 8. iii. 1980, dung heap; 3 females and 2 males, Tamil Nadu: Coimbatore, T.N.A.U. campus, Central dairy Farm, 13. iii. 1980, ex dung heap; 2 females; Madras, Adiyar, near I.I.T., 6. iii. 1980, ex ass dung; 3 females, Madras Deer Park, 6. iii. 1980, ex leaf litter; 4 females, Madras, Zoo Garden, 5. iii. 1980, ex grassy soil; 2 females, Tripura: Agartala, Arundhutinagar, 8. x. 1978, ex dung heap, R.P. Shah coll.; 2 females, Sabrum, near Inspection Bungalow, 14. x. 1978, ex compost heap, R.P.Shah coll., 2 females, Dharmanagar, 3. x. 1978, ex decaying grasses, R.P.Shah coll.; 3 females, West Bengal: 24 Pargana Dist., Sonarpur, Sitala, collection data unstated, *Heliocopris buçephalus* (F.) S.K. Bhattacharyya coll.; 9 females, 24 Parganas District, 15 iii. 1976, *Heliocopis dominus* Bates, S.K. Bhattacharyya coll.

Distribution: China (Samsinak 1962, Cas. csl. spol. entom. 59: 186-204) and India.

INDIA: Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Nagaland, Pondicherry, Tamil Nadu, Tripura and West Bengal.

Remarks: The species is very common in India occurring in various litter, soil and dung samples and also in association with beetles. According to Samsinak's description, the dorsal setae j1, j4 and s2 are of the same appearance with their terminations club-like and smooth; but these setae are mostly with distal pilosity in the material collected in India. Lateral margins are smooth in Indian specimens in contrast to their Chinese counterpart. Since the original description, the present report represents the first subsequent collection from another geographic region. The male is recorded for the first time. Sternal shield features and the nature of dorsal chaetotaxy of the species are typical of the *glaber* group.

ACKNOWLEDGEMENT

I thank Dr. Karel Samsinak, Entomological Institute of the Czechoslovak Academy of Sciences, Prague, for making available to me pertinent literature and for comparing the diagrams and photographs for determination of the species.

May 19, 1995

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32. TWO ADDITIONAL SPECIES OF BRASSICACEAE FOR THE FLORA OF ORISSA

(*With a text figure*)

During a critical study of herbarium and live specimens of the family Brassicaceae pertaining to the flora of Orissa. We came across two wild species of the family which have not hitherto been reported to occur in the state. These two taxa turned out to be new plant records for Orissa and are of considerable phytogeographical significance. Nomenclature, short botanical description, phenology, collection number, place and date of collection, ecological and nomenclatural notes, etc. have been provided for both the species. The specimens have been housed in the Herbarium of Regional Plant Resource Centre, Bhubaneswar (RPRC).

Cardamine scutata Thunb., Trans. Linn. Soc.

Lond. 2: 339. 1794; Hara, Journ. Fac. Sci. Univ. Tokyo Bot. 6:59. 1952; Babu, Herb. Fl. Dehra Dun 57. 1977. (*Cardamine hirsuta* Linn. var. *sylvatica* sensu Haines, Bot. Bihar and Orissa 1: 27. 1921 (non *Cardamine sylvatica* Linn., 1803).

Sub-erect, glabrous or puberulous, annual herbs. Stem simple or sparsely branched, obscurely ribbed. Leaves alternate, pinnately 3-7 lobed; leaflets usually small and rounded, often dentate or lobulate, terminal leaflet 3 (rarely 5)-lobed. Racemes terminal, many-flowered. Flowers white. Sepals clawed, narrow. Stamens 6. Ovary sub-sessile, linear; ovules 2-seriate; style very short; stigma entire, hairy. Siliqua compressed, linear, tapering at both ends, not beaked; valves with distinct mid-rib, curling up elastically on dehiscence.

Not very common; locally abundant in damp and shady places.

Fls. & Frts.: February-June.

Specimens examined: Regional Plant Resource Centre (Ekamrakanan) premises (Khurda district), 1.2.1990, *P.C. Panda* 558; 16.5.1995, *R.K. Moharana* 4776; State Botanical Garden, Barang (Cuttack district), 6.9.1992, *P.C. Panda* 2977.

Distribution: Indomalaya (INDIA-U.P., M.P., H.P., West Bengal, Bihar and Orissa).

Rorippa montana (Hook. f. & Thoms.) Small, Fl. S.E.U.S. (ed. 2) 1336. 1913. *Nasturtium montanum* Wall. ex Hook. f. and Thoms. J. Proc. Linn. Soc. Bot. 5: 139.1861.

Erect. glabrous, perennial herbs. Leaves usually entire, crenate, elliptic-oblong, alternate. Racemes terminal, many-flowered, elongating in fruiting. Flowers small, yellow. Sepals elliptic-oblong, not pouched. Petals 4. Ovary sub-sessile, linear; style short; stigma entire on obscurely 2-lobed, hairy. Fruit linear, terete, dehiscent, 2.5-3.5 cm long, less than 0.1 cm wide; seeds many, 2-seriate. (Fig. 1)

Occasional, a weed in moist shady localities in gardens.

Fls. and Frs.: December-June.

Specimens examined: Regional Plant Resource Centre (Ekamrakanan) Campus, (Khurda District), 30.1.1990, *S.C. Jena 555;* 5.3.1990, *R.K. Moharana* 3630.

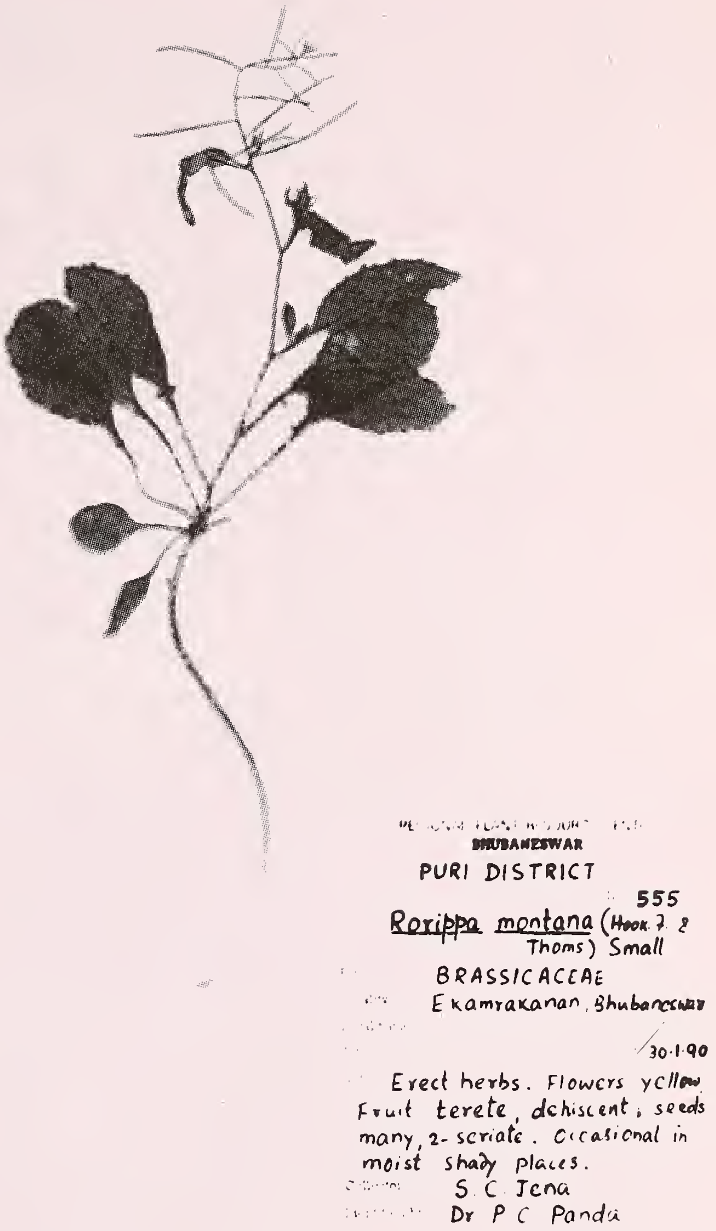
BHUBANESWAR
PURI DISTRICT
555
Rorippa montana (Hook. f. & Thoms) Small
BRASSICACEAE
Ekamrakanan, Bhubaneswar
30·1·90
Erect herbs. Flowers yellow. Fruit terete, dehiscent; seeds many, 2-seriate. Occasional in moist shady places.
S. C. Jena
Dr P C Panda

Fig. 1 Herbarium specimens of *Rorippa montana* (Hook. f. & Thoms.) Small.

Distribution: Indomalaya (INDIA-U.P., M.P., H.P., Karnataka and Orissa).

Note: Babu (1977) has cited *Nasturtium montanum* Wall. ex Hook. f. and Thoms. [=*Rorippa montana* (Hook. f. & Thoms.) Small] as a new synomym under *R. indica* (Linn.) Hiern and considered the former as conspecific with the latter. Saxena and Brahmam (1994) have also held the above view in taxonomic treatment of these two taxa based on study of pertinent literature; but no specimens have been examined to arrive at this conclusion. The description of leaf and fruit provided in these works are also different from the one given above. After critical study of a large number of live specimens in the field and also herbarium materials of both *Rorippa indica* and *R. montana,* we are of the opinion that *R. indica* and *R. montana* are undoubtedly two distinct species which can be distinguished from each other by the following consistent key characters. A similar treatment has also been followed by Singh (1984) and Panigrahi and Murti (1989).

1. Sub-erect herbs. Leaves pinnatifid; pinnae ovate-lanceolate, dentate. Fruit 1.5 to 1.75 cm long and 0.2-0.3 cm wide .... *R. indica*
— Erect herbs. Leaves usually not lobed, crenate, elliptic-oblong. Fruit 2.5 to 3.5 cm long, never more than 0.1 cm wide .... *R. montana*

September 7, 1995

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Saxena, H.O. & M. Brahmam (1994): The flora of Orissa, Vol. I. Regional Research Laboratory and Orissa Forest Development Corporation, Bhubaneswar.

Singh, B.G. (1984): Brassicaceae. *In*: Flora of Karnataka, Vol. I (C.J. Saldahna, Ed.). Oxford & IBH Publishing Co., New Delhi pp. 320-324.

33. *HELICTERES ISORA* - A KEYSTONE SPECIES

Helicteres isora Linn. (Sterculiaceae) is a common undergrowth shrub in the deciduous forests of southern India. Very little has been reported on the pollination aspects of *Helicteres,* though it is known to be frequented by birds (Subramanya and Radhamani 1993). These authors have reported that three species of birds visit it: Hill Myna (*Gracula religiosa*), Purplerumped Sunbird (*Nectarinia zeylonica*) and Purple Sunbird (*Nectarinia asiatica*). In another note (Santharam 1996), I discuss the visitation patterns in terms of frequency and temporal activity of the various visitors to a clump of *Helicteres*. Though it exhibits typical characteristics of a bird flower, *Helicteres* is also frequented by several butterflies. But they visit fewer flowers in comparison with birds (Santharam 1996).

These observations were made at Mundanthurai Tiger Reserve in Tamil Nadu and the Peechi-Vazhani Wildlife Sanctuary in Kerala. The observations at the former site were made during January, 1988 and at the latter site between August 1991 and May 1993. At Peechi-Vazhani, flowers were seen in the months of August to October while at Mundanthurai, flowers were present in the month of January. The differences in flowering dates at the two sites may be related to the rainfall patterns at the sites: the Kerala side of the Western Ghats receives rain in the months June-August (Southwest monsoon) while in Tamil Nadu, rain is delayed until the onset of the Northeast monsoon in late October and last until late December.

I present a list of animals (Table 1) that were seen visiting the flowers at the two sites. This list includes 21 species of birds, nine species of butterflies and one mammal. It may be noted that the species listed from Peechi may not be complete as no intensive studies were conducted.

This impressive list of animals seen feeding on the nectar of this shrub indicates that it may be an important keystone species for the nectar-feeding guild. Besides, this is a very common species, flowering synchronously at the beginning of the dry season, earlier than that of the other bird flowers such as *Bombax, Erythrina* and *Butea* (pers. obs.).

TABLE 1
LIST OF ANIMALS SEEN FEEDING ON THE NECTAR OF *Helicteres isora*

Species	Mund.	Peechi
BIRDS		
Chalcophaps indica (Emerald Dove)	-	+
Psittacula cyanocephala (Blossomheaded Parakeet)	+	-
Loriculus vernalis (Lorikeet)	-	+
Dinopium benghalense (Lesser Goldenbacked Woodpecker)	-	+
Oriolus oriolus (Golden Oriole)	-	+
Dicrurus leucophaeus (Grey Drongo)	+	+
Dicrurus caerulescens (Whitebellied Drongo)	+	+
Dicrurus paradiseus (Racket-tailed Drongo)	-	+
Sturnus malabaricus blythi (Whiteheaded Myna)	-	+
Acridotheres tristis (Common Myna)	-	+
Dendrocitta vagabunda (Common Treepie)	-	+
Chloropsis aurifrons (Goldfronted Chloropsis)	+	+
Pycnonotus jocosus (Redwhiskered Bulbul)	+	-
Pycnonotus cafer (Redvented Bulbul)	+	+
Pycnonotus luteolus (Whitebrowed Bulbul)	+	-
Turdoides striatus (Jungle Babbler)	+	+
Acrocephalus dumetorum (Blyth's Reed Warbler)	+	-
Dicaeum concolor (Nilgiri Flowerpecker)	-	+
Nectarinia zeylonica (Purplerumped Sunbird)	+	+
Nectarinia asiatica (Purple Sunbird)	+	-
Arachnothera longirostris (Little Spiderhunter)	-	+
BUTTERFLIES		
Troides helena (Common Birdwing)	-	+
Pachilopta hector (Crimson Rose)	+	-
Princeps polytes (Common Mormon)	+	-
Neptis hylas (Common Sailer)	+	-
Delias eucharis (Common Jezebel)	+	-
Euploea core (Common Crow)	+	-
Moduza procris (The Commander)	+	-
(+ 2 unidentified butterfly species were seen at Mundanthurai)		
MAMMAL		
Funambulus palmarum (Threestriped Palm Squirrel)	+	-

ACKNOWLEDGEMENTS

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August 2, 1995

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34. SOME NEW COMBINATIONS IN ASTERACEAE

Precursor to the Flora of Sikkim, following new combinations are necessary:

1. *Ligularia lancifer* (J.R. Drumm.) R.C. Srivastava & C. Jeffrey, comb. nov.

Senecio lancifer J.R. Drumm. in Kew Bull. 6:270.1911.

2. *Parasenecio chola* (W.W. Smith) R.C. Srivastava & C. Jeffrey, comb. nov.

Senecio chola W.W. Smith in J. Asiat. Soc. Beng. n.s. 7:72. 1911.

3. *Parasenecio pentaloba* (Hand.-Mazz.) R.C. Srivastava & C. Jeffrey, comb. nov.

Cacalia pentaloba Hand.-Mazz. in Acta H. Gotob. 12,298.1938.

4. *Parasenecio mortonii* (C.B. Clarke) R.C. Srivastava & C. Jeffrey comb. nov.

Senecio mortonii C.B. Clarke, Comp. Ind. 208.1876.

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35. MICRO-MORPHOLOGY OF *AEGINETIA INDICA* L. SEED

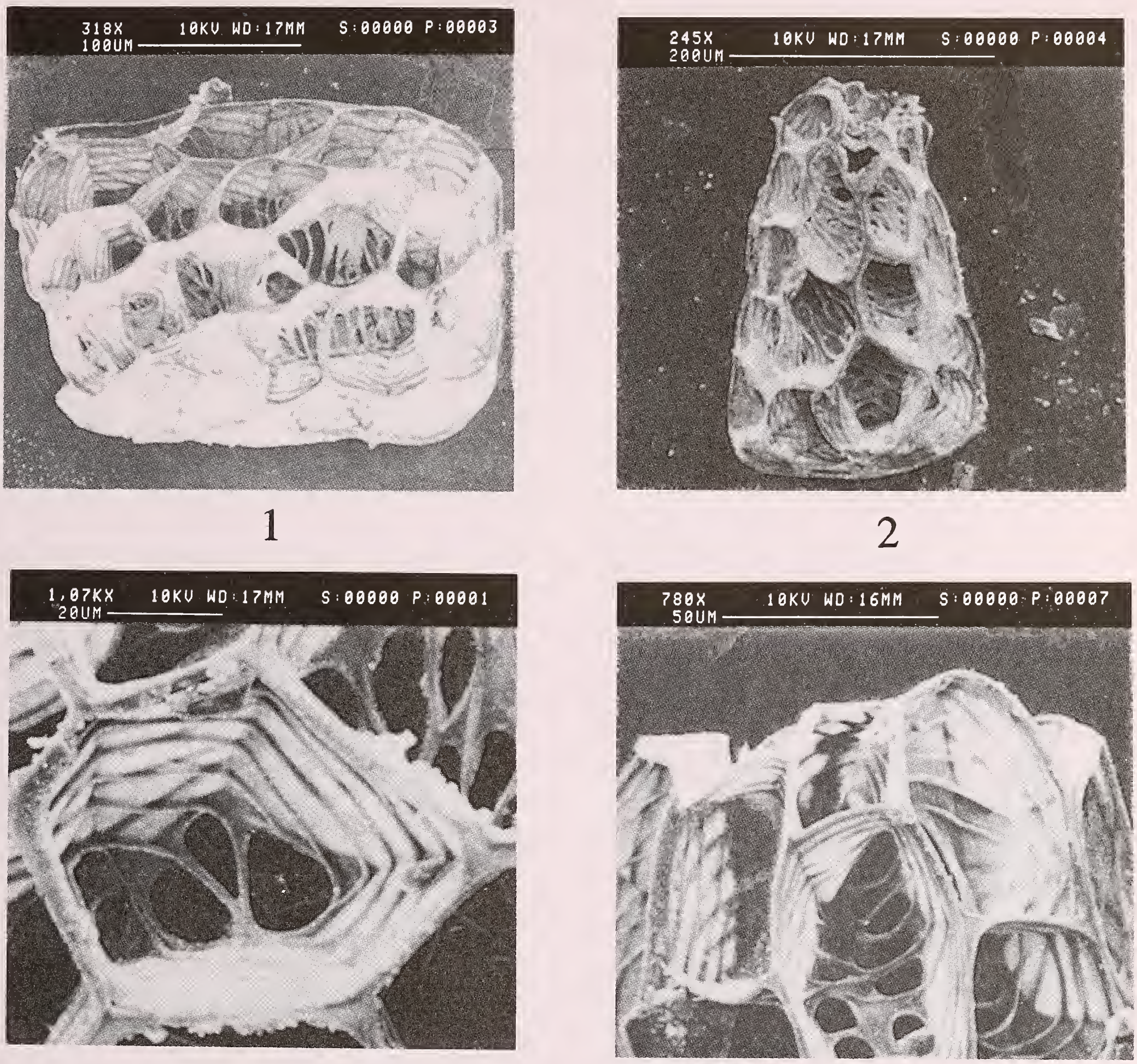
(*With four text-figures*)

During the medico-botanical studies in western Maharashtra, the brownish-black powder of the epiphyte *Aeginetia indica* L. was recorded to be useful in painful menstruation. The capsules of *A. indica* were collected and analyzed in laboratory. On the basis of external appearances, it was difficult to guess the nature of brownish black structures liberated from the capsules.

In the laboratory, observations under light microscope revealed that the black powder consists of the seeds of *Aeginetia indica.* Floristic reports (Hooker 1885, Cooke 1906) on exomorphic characters mention the minute size, yellowish-brown colour of seeds. But no more structural details could be found in available literature though reports on host-parasite relationship of this species are available (Padte *et al.* 1978). Hence, seed-coat micro-morphology was studied using scanning electron microscope with respect to its surface characterization in relation to taxonomy.

The collected seed material was fixed in 4% formaldehyde (24 hr), passed through 10% - 100% acetone grades (30 min. each) and mounted in jelly. The usual gold coating was followed for SEM observations.

Micro-morphology of the seeds of *A. indica* (Family: Aeginetiaceae) was carried out using Stereoscan S120, Cambridge Microscope. It was noticed that the seeds are minute brownish-black in colour. Most of them are triangular in shape, but occasionally round or squarish oval seeds are also observed. Seed size ranges from 86.66 μm x 58.66 μm to 184.21 μm x 300 μm. External appearance of the seed shows polygonal or irregularly shaped epidermal cells, which are raised and depressed. The characteristic reticulation is observed which is of rugose reticulate type (Figs. 1-4). Dimensions of single polygon (average) 50 μm x 45 μm to 80 μm x 70 μm.


318X 10KV WD:17MM S:00000 P:00003
100UM
245X 10KV WD:17MM S:00000 P:00004
200UM
1,07KX 10KV WD:17MM S:00000 P:00001
20UM
780X 10KV WD:16MM S:00000 P:00007
50UM

1 2

3 4

Figs. 1-4. *Aeginetia indica* seeds under SEM. 1. Seed having circular circumference; 2. Triangular, seed; 3. Polygonal cells with rugose reticulation; 4. Micropylar end of the seed.

The polygonal cup-like cells form cavities. These may store water which is useful at the time of germination or may help in preventing desiccation. These characters can be utilized in the identification of species especially while working with herbarium materials as they retain their form even after drying.

June 12, 1995

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36. REDISCOVERY OF *STREPTOCAULON SYLVESTRE* WIGHT - AN ENDANGERED AND LITTLE KNOWN ENDEMIC PLANT OF EASTERN INDIA

(*With a text-figure*)

Streptocaulon sylvestre Wight (Asclepiadaceae) is a small suffrutescent prostrate plant, originally collected by Hamilton (Ham. Herb. No. 763) from Sannyasikata (not *Sanaashygota* as in Wight 1834) in the district of Jalpaiguri (West Bengal, India) on 7th of April 1809 and doubtfully thought to be a species of *Periploca*. Later Wight (1834) named it as *Streptocaulon sylvestre*. Wallich recorded the specimen in his catalogue of dried specimens in 1847 (Wall. Cat. No. 8251), with no duplicate.

S. sylvestre is a very rare plant and is reported to grow only in the foothill regions (Terai) of Eastern Himalaya, namely Siliguri (in West Bengal) and foothills of Sikkim Himalayas (Hooker 1883, Prain 1903). Apart from the Type (Ham. Herb. no. 763 in CAL) only few specimens were located at CAL: C.B. Clark 11656 (2 sheets), Siliguree (= Siliguri), May 27, 1870; C.B. Clark 11707, Purnea, May 24, 1870; C. B. Clark 26455 (2 sheets), Siliguree, May 31, 1875; Ribu and Shomoo 3790, Titalya (Terai plains), March 4, 1910. No other specimen was found in any other Indian Herbaria. However, no material from Sikkim was seen.

It now appears that the species is endemic to the Terai region of Bihar and West Bengal (Sikkim?) in India. So far, only two floras, the *Flora of British India* (Hooker 1883) and *Bengal Plants* (Prain 1903, using same specimen), have recorded the species. Hara and his co-workers (Hara 1966, 1971; Ohashi 1975; Hara *et al.* 1978, 1979, 1982) floristically explored the adjoining regions of its places of original distribution but have not recorded the plant.

Quite a few plants are now found growing in a field with savannah type of vegetation with thick grass cover within the campus of the University of North Bengal. This grassland is free from grazing and is dominated by *Cymbopogon pendulus* (Nees ex Steudel) W. Weston, *Saccharum spontaneum* L. and *Imperata cylindrica* (L.) Beauv. and attains a height of over 2 m in flowering season of the first species (i.e. September to January). However, mowing of grasses for fodder is a common practice.

Search has been made in the regions adjoining the University campus, at some places in Purnea, the Type locality, i.e. at Sannyasikata, and in a wide area of the Terai during the last four years but with no success. Large scale modification of these areas during the last two centuries for dwelling and cultivation (as for the rapid expansion of Siliguri Municipality), the manifold increase in grazing, probably led to the elimination of the species from these areas. The strictly prostrate habit of the plant with slightly woody but easily breakable stem, which never produces any adventitious root (from nodes and/or internodes) but always grows under grasses renders the species highly unsuitable for a rangeland flora.

No detailed description, specially of its fruits and seeds, as well as a drawing, is available in the existing literature. These are given here to facilitate further exploration of the species.

Streptocaulon sylvestre Wight, Contrib. Ind. Bot. 65 (1834): Fl. Brit. Ind. 4:10 (1883); Beng. Pl. 2:509 (1903). (Fig. 1)

A suffrutescent strictly procumbent herb with

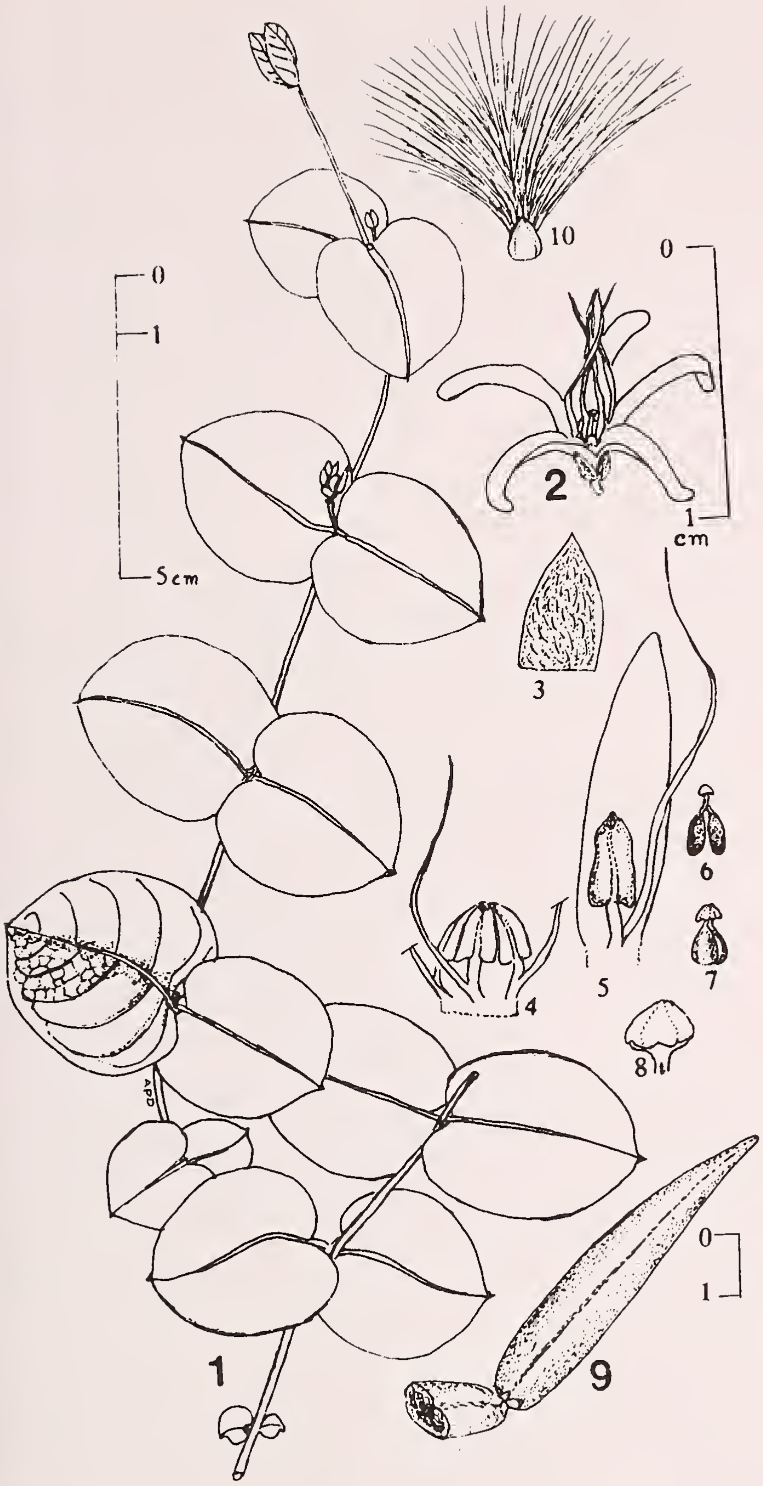

Fig. 1. *Streptocaulon sylvestre* Wight
1. A twig; 2. Flower; 3. A sepal; 4. Androecium;
5. A stamen on a petal; 6. Bipollinium; 7. Pistil;
8. Stigma; 9. Pair of follicles; 10. Seed with coma.

milky latex, never rooting from branches; stem terete, *c.* 0.13 cm in diameter, shortly tomentose. Leaves opposite, with 0.3-0.4 cm long petiole; lamina (4-6.3 x 3.8 - 5.7 cm) ovate to rounded-ovate, entire, apiculate, shortly cordate-auriculate, leathery, shortly hispid below, minutely pubescent above; 5-veined from base, midvein strong, 5-7 nerved laterally, all veins elevated below. Bracts linear-subulate, 0.15 - 0.22 cm long, hairy. Flowers in axillary, shortly peduncled (0.5 - 0.8 cm), 1-9 flowered cymes, shortly pedicellate (0.5 - 1.1 cm), actinomorphic, hypogynous, bisexual, 1-1.2 cm in diameter. Sepals 5, 0.2-0.25 x 0.08-0.09 cm, connate only at base, broadly ovate, entire, acute, hairy, quincuncial, brownish-purple, alternating with linear glands at base, slightly enlarged in fruit. Corolla rotate with a very short (0.1 cm) greenish - white tube; lobes 5, 0.7-0.8 x 0.15 cm, linear oblong, obtuse, twisted to the right, curved downward after opening, deep purple. Stamens 5, inserted on the base of corolla, antipetalous; filaments short (0.04 - 0.1 cm), flattened, white, alternating with minute teeth; anthers flattened, 0.1 - 0.11 cm, oblong, bithecal, base slightly sagittate, with a short triangular corona, connivent and attached near the tip of stigma; pollen masses 2 in each cell, linear, attached to a slender and short corpuscle, tip dialated; corona produced from the base of filament, slender whip-like, 0.6-0.65 cm long, deep brown at base, white above, tips do not coil. Carpels 2, united little below the stigma; ovaries 2, oblong, 0.7 - 0.75 cm long, hairy, 1-chambered each, ovules numerous, inserted on marginal placenta; style short; stigma conical, cap-like margin 5-lobed, each lobe cordate, obscurely 2-lobed at tip. One of the pair of follicles generally does not develop but becomes equal if it grows, terete with a longitudinal ventral furrow, conical from middle to tip, or lower 3/5 oblong and conical above, smooth walled, minutely villous, 3.8 - 8.8 x 1-1.3 cm, dehiscent; seeds (0.6 - 0.85 x 0.4) numerous, ovate-oblong to ovate, flat, reddish brown; hairs of coma 1 - 4.4 cm long, white.

Specimen cited: *A.P. DAS 1917,* North Bengal University campus, September 16, 1990 (Herbarium NBU).

It is now clear that this endemic species (for Terai of West Bengal and Bihar) with beautiful foliage and deep purple flowers is now extremely endangered. Further extention programme of the University may, any day, eliminate the species from its last known natural habitat. However, quite a few plants are now growing well in pots and on the ground inside the Medicinal and Rare Plants Garden and Padmaja Naidu Park of the University. Some seeds have been collected for germination studies and for further propagation.

ACKNOWLEDGEMENTS

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37. PRESENCE OF WILD PLANTAIN (*ENSETE SUPERBUM*) IN RAJASTHAN

In the Flora of Rajasthan, Vols. I, II & III; Shetty and Singh (1987, 1991, 1993) have recorded only, *Musa paradisiaca* Linn. as a representative plant of family Musaceae from the State of Rajasthan. During my field visits since 1986 in forest areas of Jhadol, Kotra, Mamer and Ogna Forest Ranges of Southern Aravallis in Udaipur district, I have observed wild plantain (*Ensete superbum*) growing in different Reserve Forests as given in Table 1.

TABLE 1
DISTRIBUTION OF *E. superbum* IN RAJASTHAN

Name of Forest	Forest Range	Forest Div.	Approx. no. of plants observed
1. Daiya-Ambasa	Mamer	Udaipur (W.L.)	20
2. Kamalnath	Jhadol	Udaipur (S)	5
3. Madri	Jhadol	Udaipur (S)	1
4. Nal Sandol	Jhadol	Udaipur (S)	100
5. Phulwari-ki-Nal	Kotra	Udaipur (W.L.)	30
6. Ramkunda	Ogna	Udaipur (S)	70

Invariably it occurs on inaccessible crags and is patchily distributed in forest areas. At Na Sandol Reserve Forest, it grows in crevices of bare rocks in association with *Euphorbia caducifolia.* The *E. superbum* is mainly distributed in the western part of South India which has a high rainfall area while it grows in Rajasthan, in the 600-800 mm rainfall zone. At the commencement of the monsoon rains it produces new leaves from its perennial underground parts and becomes dry in October-November. It has a swollen pseudostem base and is monocarpic, rarely suckering.

This plant is familiarly known to the Bhils (local tribals) as "Magra ko kelo" or "Magra kel", i.e. banana of the hills. It is used in some ethnomedicines also. Sap of leaves of this plant is given to cure infertility among women. This plant is useful from the ethnometeorological point of view also. New sproutings of this plant is taken as an indication of commencement of monsoon rains by local tribals and preparation for sowing of Kharif crop is made accordingly.

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I am very grateful to Dr. R.P. Pandey, BSI, Jodhpur; Dr. V.A. Amalraj, NBPGR, Trichur and Dr. P. Joshi, TBGRI, Pacha-Palode for providing information about the species.

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38. *RIKLIELLA KERNII* (RAYMOND) RAYNAL, A NEW RECORD FOR ANDHRA PRADESH

(*With a text-figure*)

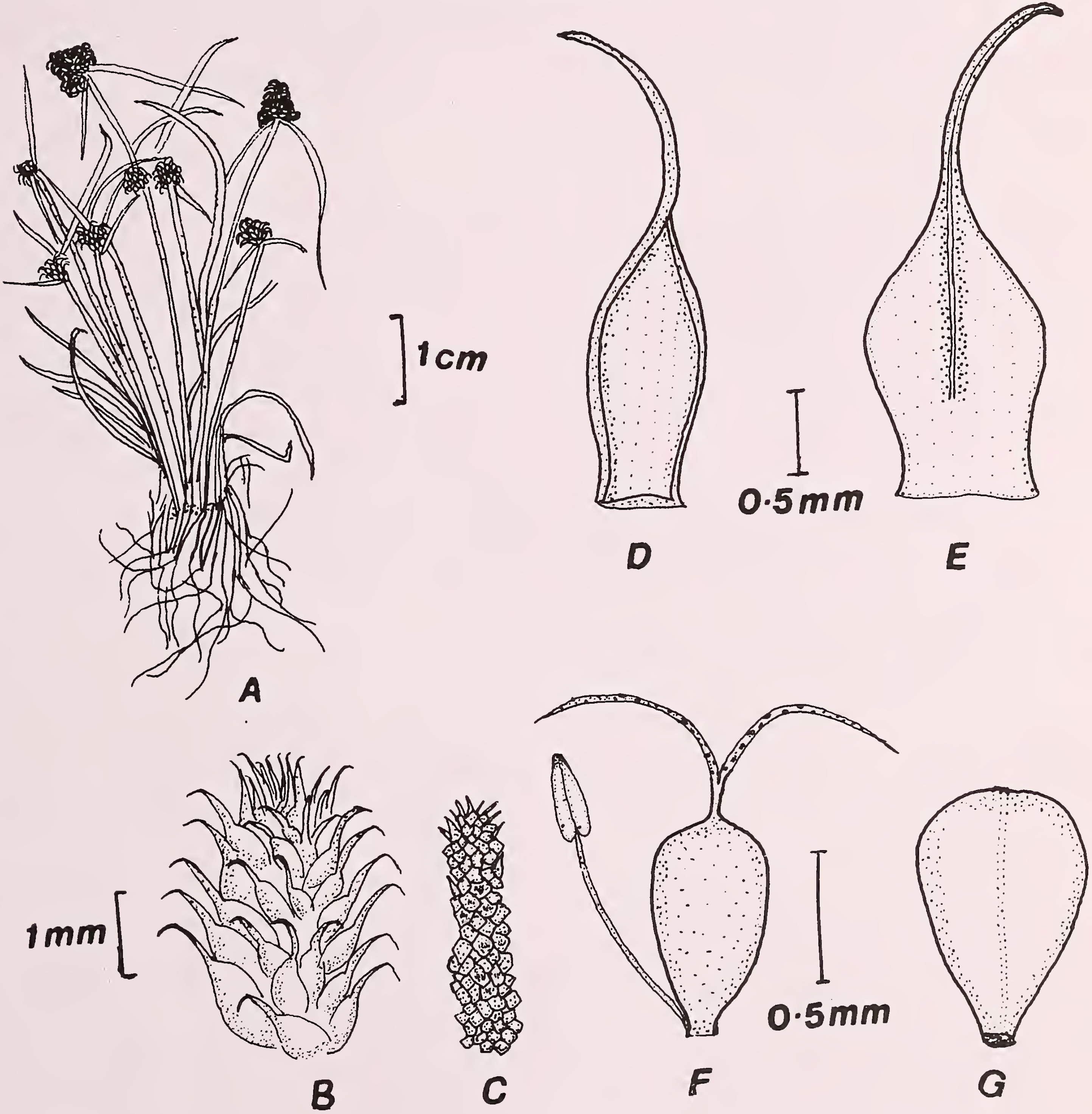

Fig. 1. *Rikliella kernii* (Raymond) Raynal: A. Twig; B. Spike; C. Rhachilla; D. & E. Glume entire and spread out; F. Pistil with stamen; G. Nut.

Intensive floristic explorations for aquatic angiosperm taxa in Andhra Pradesh yielded one rare and interesting taxon. Based on critical taxonomic studies and comparisons with authenticated specimens at MH and CAL, this was identified as *Rikliella kernii* (Raymond) Raynal. This was hitherto not reported from Andhra Pradesh. Brief description along with nomenclatural citation, ecological and phenological data is provided to facilitate easy identification.

Rikliella kernii (Raymond) J. Raynal, Adansonia Ser. 2,13:155.1973.

Scirpus kernii Raymond, Naturaliste Canad. 86:230.1959; Raynal, Adansonia ser.2,8:95, t.1, f.1-5.1968; Saldanha and Nicolson in Fl. Hassan District, 695-696.1976. (Fig. 1)

Small tufted annual with brownish fibrous roots. Culms few to several, slender, up to 6 cm tall. Leaves only at base, 1-3 to a culm, filiform, subacute at apex, sheaths papery red-purple. Spikes oblong-ovoid, bearing many glumes imbricated on a straight rhachis; spikelets reduced to a single glume subtending a bisexual flower; glumes obdeltoid-obovate, cuneate; with an arista of equal length; stamens one; style very short. Achenes obovate.

Ecology: Moist places at low elevations, rare.

Flowering: August - December.

Distribution: WORLD: Tropical Africa. INDIA: Karnataka, Madhya Pradesh, Andhra Pradesh.

Specimens examined: Nirmal (Adilabad District), MHR & KI - 14577.

Note: *Rikliella kernii* (Raymond) Raynal is mostly akin to *Rikliella squarrosa* (L.) Raynal but it can be distinguished from the latter by its narrow leaves, bi-fid stigma and distantly spreading bracts.

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39. SOME LITTLE KNOWN AND RARE HIGH ALTITUDE SPECIES OF *POA* FROM GARHWAL HIMALAYA

Garhwal Himalaya represents one of the most interesting floristic zones, not only in the Himalayan belt but of the Indian subcontinent because of rich vegetational diversity, sustained in varied topographic, climatic and edaphic extents. The Poaceae is represented by maximum number of species (Duthie 1906), and the type genus *Poa* is the most interesting one, on account of its distribution in the temperate and alpine zones of the Himalayas as well as its ambiguity in taxonomic details, as it requires critical microscopic observations of glumes, lemmas, paleas, anthers and other phenotypic features (Rajbhandari 1991). In recent efforts on the floristic explorations to Garhwal Himalaya, we collected some interesting species of *Poa* from high altitude zones of Garhwal Himalaya. Perusal of literature (Hooker 1896, Duthie 1906, Bor 1960, Semwal and Gaur 1983, 1986; Naithani 1985; Rajbhandari 1991; Uniyal *et al.* 1994), indicated that these species are new and or rare records from this part of the Himalaya, representing extension of their eastward or westward distribution.

A key of these little known species of *Poa* together with brief description along with their habitat, occurrence, approximate elevation and collector's herbarium number is given. Plant specimens were matched with the authentic specimens of Botanical Survey, Northern Circle, (BSD) and Forest Research Institute, (DD), Dehradun and deposited at the Herbarium H.N.B. Garhwal University, Srinagar-Garhwal (GUH).

KEY TO THE SPECIES OF *Poa*

- 1.1 Basal sheaths with a bulbous thickening at the base:
  - 2.1 Lemma keel scabrid; spikelets non-proliferous .... 2. *P. bacteriana*
  - 2.2 Lemma keel ciliate on the lower part; spikelets proliferous. .... 3. *P. bulbosa*
- 1.2 Basal sheaths without bulbous thickening at the base:
  - 3.1 Tufted non-rhizomatous plants:
    - 4.1 Panicle spreading; palea keels scabrid:
      - 5.1 Lemma quite glabrous, broadly hyaline on the margins only. .... *P. aitchisonii*
      - 5.2 Lemma at least ciliate on the keels and nerves, hyaline on the margins as well as at the tips:
      - 6.1 Lower glumes smaller, reaching half-way up on the lowest lemma, or less; lemmas 3.4-4.5 mm long. .... 4. *P. himalayana*
      - 6.2 Lower glumes longer than half the lowest lemma; lemmas 3-4 mm long:
        - 7.1 Lemmatal nerves conspicuous; lower glumes very narrow, 1-nerved; lowest branches of the panicle 3-5 nate. .... 5. *P. khasiana*
        - 7.2 Lemmatal nerves inconspicuous; lower glumes lanceolate or elliptic, 3-nerved; lower branches of the panicle 2-nate. .... 10. *P. sterlis*
    - 4.2 Panicle branches ascending densely contracted; palea keels semipilose. 6. *P. koelzii*
  - 3.2 Rhizomatous plants:
    - 8.1 Plants conspicuously curved at the base; ligules short, about 1 mm long. .... 7. *P. pratensis* ssp. *alpigena*
    - 8.2 Plants erect from the base; ligules 1.5-2.3 mm long:
      - 9.1 Basal leaves narrow, almost setaceous; ligules 1.5-2 mm long. .... 8. *P. pratensis* ssp. *anguistifolia*
      - 9.2 Basal leaves broad and flat; ligules 2-2.3 mm long. .... 9. *P. pratensis* ssp. *pratensis*

Poa aitchisonii Boiss. Fl. Orient. 5: 602. 1884; Bor in J. Bombay nat. Hist. Soc. 50: 835. 1953; GBCIP 554. 1960.

Tufted, 14-27 cm tall herbs; leaves flat; sheaths glabrous; ligules 0.8-1 mm long; panicle spreading; spikelets 3-5 flowered; anthers. 1.9-2 mm long.

Fl. & Fr.: October-November.

Specimen examined: Dali (Chamoli), 3900 m, D.C. Nautiyal, GUH: 14,001.

The species occurs in sporadic patches along the open alpine meadows, usually associated with species of *Kobresia* and *Carex*. Earlier, the species was recorded from the far North West Himalaya, Kurram Valley and Afghanistan (*see* Bor 1960).

P. bacteriana Roshev. in Bot. Mater. Gerb. Glavn. Bot. Sada 4: 93. 1923; Bor, GBCIP. 556. 1960; Cope in Nasir & Ali, Fl. Pak. 143: 403. 1982.

Tufted, 2-3 noded herbs; 20-48 cm tall; leaves flat or folded; sheaths glabrous, bulbous at the base; ligules 1.5-3 mm long; panicle branches ascending; anthers 1.5-1.7 mm long.

Fl. & Fr.: June-July.

Specimen examined: Tapovan (Uttarkashi), 5000 m, D.C. Nautiyal, GUH: 14,003.

Rare, along the alpine slopes, usually associated with species of *Pedicularis, Astragallus* and *Leontopodium*, etc. Earlier this species was reported from Lahul (H.P.) by Bor (1960) and Aswal and Mehrotra (1994).

P. bulbosa L., Sp. Pl. ed. 1: 70. 1753; Hook.f., Fl. Brit. Ind. 7: 338. 1896; Bor, GBCIP. 556. 1960; Uniyal *et al.*, Grasses. U.P. 72. 1994.

Tufted herbs; 18-42 cm tall, nodes 2; leaves flat or folded; sheaths glabrous, bulbous at base; ligules 1.2-3 mm long; spikelets mostly proliferous; anthers 1-1.3 mm long.

Fl. & Fr.: June-July.

Specimen examined: Gaumukh (Uttarkashi), 4500 m, D.C. Nautiyal, GUH: 14,004.

This species was collected from a high altitude zone along the Gaumukh glacier. Rare, associated with *Trisetum spicatum, Saxifraga* and *Androsace* populations. This species was reported from Lahul valley (Bor, 1960, Aswal and Mehrotra 1994).

P. himalayana Nees ex Steud., syn. Pl. Glum. 1: 256. 1854; Hook.f., Fl. Brit. Ind. 7: 344. 1896; Bor, GBCIP. 557. 1960; Uniyal *et al.*, Grasses. U.P. 72. 1994.

Tufted, sometimes stoloniferous, terete, 3-5 noded herbs; leaf blades flat; sheaths glabrous;

ligules 0.8-1.6 mm long; panicle branches spreading; spikelets 2-3 flowered; anthers 0.7-1 mm long.

Fl. & Fr.: June-July.

Specimen examined: Chirbasa (Uttarkashi), Yamnotri (Tehri Garhwal), 3500 m, D.C. Nautiyal, GUH: 14,006, 14,915.

Rare, in scattered population, only a few specimens collected under moist boulders. This was recorded from Sikkim (Hooker 1896, Bor 1960).

P. khasiana Stapf in Hook.f., Fl. Brit. Ind. 7: 343. 1896; Bor in J. Bombay nat. Hist. Soc. 50: 830. 1952; GBCIP. 557. 1960.

Loosely tufted herbs; 20-56 cm, terete, smooth; leaves flat; sheaths glabrous; ligules 0.8-2 mm long; panicle spreading, lower branches 3-5; spikelets 2-3-flowered; anthers 0.7-1 mm long.

Fl. & Fr.: June-July.

Specimen examined: Bhojbasa (Uttarkashi), 3900 m, D.C. Nautiyal, GUH: 14,008.

Rare, occurs under rock crevices and in between boulders, in shady localities. This species has been reported from eastern Himalaya particularly from Khasia and Shillong hills (Hooker, 1896, Bor 1960).

P. koelzii Bor in Kew Bull. 1948; 139. 1948; GBCIP. 557. 1960; Uniyal *et al.*, Grasses. U.P. 75. 1994.

Densely tufted herbs; culms not above 15 cm tall, glaucous or not, nodes 1-2; leaf blades folded, glaucous, glabrous; sheaths glabrous; ligules 1.2-2 mm long; panicle 6 cm long; branches ascending; palea keels semipilose; anthers 1.2-1-5 mm long.

Fl. & Fr.: October-November

Specimen examined: Gaumukh (Uttarkashi), 4000 m, D.C. Nautiyal, GUH: 14,009.

Rare. Under rock crevices and boulders, associated with *Deuxia pulchella, Elymus nutans* and *Kobresia* sp. Earlier this species was reported from Kashmir (Bor 1960) and Lahul, H.P. (Aswal and Mehrotra 1994).

P. pratensis subsp. **alpigena** (Blytt.) Hitt., Suomkasvio: 205. 1933. *P. alpigena* Lindm., Svensk Fanerogam. Fl. 91. 1918; Bor, GBCIP. 555. 1960; Uniyal *et al.*, Grasses. U.P. 72. 1994.

Rhizomatous herbs, with curved underground stem; culms 6-22 cm, node 2-3; leaves flat; sheaths glabrous; ligules 1.1-1.5 mm long; panicle branches spreading or ascending; anthers 1.5-1.6 mm long.

Fl. & Fr.: June-July.

Specimen examined: Tapovan (Uttarkashi), 5000 m, D.C. Nautiyal, GUH: 14,011.

Rare, on alpine meadows, on sandy soil and associated with *Elymus nutans, Polygonum* and *Kobresia.* Earlier reported from Yatung and Gyanste in Tibet (*see* Bor 1960).

P. pratensis subsp. **anguistifolia** (L.) Gaud., Agrost. Helv. 1: 214. 1811; Uniyal *et al.*, Grasses. U.P. 75. 1994, *P. anguistifolia* L., Sp. Pl. ed. 1: 67. 1753; Bor, GBCIP. 555. 1960. *P. pratensis* L. sub sp. *pratensis* auct. non L.: Ohwi in Hara. Fl. E. Himal. 2: 145. 1971. *P. pratensis* L. var. *anguistifolia* (L.) J.E.Sm., Fl. Brit. 105. 1800; Hook.f., Fl. Brit. Ind. 7: 340. 1896.

Rhizomatous, erect herbs; 22-60 cm tall; leaf blades folded, almost setaceous; sheaths glabrous; ligules 1.5-2 mm long; panicle spreading; spikelets 3-4 flowered; anthers 1.2-2 mm long.

Fl. & Fr.: June-July.

Specimen examined Bhojbasa (Uttarkashi), 3900 m, D.C. Nautiyal, GUH: 14,012.

Rare, under rock crevices and shelter of boulders along the timber line zone, often associated with species of *Astragalus, Festuca* and *Geranium,* etc. This species was collected earlier from Kashmir and Tehri Garhwal by Duthie (*see* Bor 1960).

P. pratensis L., Sp. Pl. ed. 1: 67. 1753. sub sp. *pratensis* Stapf in Hook.f., Fl. Brit. Ind. 7: 339. 1896; Bor, GBCIP. 559. 1960; Uniyal *et al.*, Grasses. U.P. 75. 1994.

Rhizomatous, erect herbs; culms 6-75 cm, terete, nodes 2-3; leaves linear; sheaths glabrous; panicle spreading or ascending; anthers 1.5-2 mm long.

Fl. & Fr.: June-July.

Specimen examined: Tapovan (Uttarkashi) 5000 m, D.C. Nautiyal, GUH: 14,013.

Rare. Open alpine meadows, usually associated with species of *Primula, Ranunculus* and *Elymus,* etc. Earlier this species was reported from Kashmir and Himachal Pradesh.

P. sterlis M. Bieb., Fl. Jour. Cans. 1: 62. 1808; Bor, GBCIP. 560. 1960; Uniyal *et al.* Grasses. U.P. 75. 1994.

Tufted, scabrid herbs; culms 30-40 cm tall, nodes 2-3; leaf blades flat or sometimes convolute; sheaths glabrous or scabrid; ligules 2.5-3 m long; panicle spreading; anthers 1.7-2.2 mm long.

Fl. & Fr.: June-July.

Specimen examined:- Gangotri (Uttarkashi), 3140 m, D.C. Nautiyal, GUH: 14,014.

Rare. In moist and shady banks of streams; associated with *Festuca, Poa annua* and *Carex* sp. Species known exclusively from Ladakh and Kashmir (Bor, 1960) and from Lahul (Aswal and Mehrotra, 1994).

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January 15, 1996

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40. SOME NEW PLANT RECORDS FOR INDIA

During the course of studies on Flora of Sikkim, some interesting collections were recorded. Further studies of these specimens with the help of types/ protologues and the specimens housed at CAL, K, BSHC, and E. Herbaria and a scrutiny of the literature (Hooker 1892, Karthikeyan, *et al.* 1989) revealed that these are additions to the Flora of India. Brief taxonomic accounts of these taxa are provided here to facilitate their identification in the field.

Juncus amplifolius A. Camus in Not. Syst. 1(10): 281.1910.

Herbs. Roots-stocks stout, woody. Stems up to 35 cm high. Scale-leaves many, reddish. Rosette leaves up to 1.5 x 0.3 cm; cauline leaves up to 3, shorter than stems; sheaths without auricles. Inflorescence terminal, with 2-4 unequally peduncled capitula. Capitula *c.* 1 cm in diameter, 3-4-flowered; lowest bract leafy. Perianth lanceolate, subequal, 4.5 -6 x 1.2 -1.5 mm, dark reddish-brown. Stamens shorter than perianth, anthers 2 -2.4 mm long. Stigma lobes twisted. Capsules ellipsoid, *c.* 5 x 2.4 mm, abruptly contracted into slender exserted beak, chestnut coloured.

Fl. & Fr.: June-July.

Specimen Examined: Monlepcha-Phedang, *ca.* 3800 m, **ESIK** 750(E).

Habitat: In Abies-Rhododendron forests along streams, bogs and road-sides at 3250-4000 m

2. **Juncus bryophilus** Noltie, Edinb. J. Bot. 51(2):137-138.1994.

Herbs. Rhizomes short. Stems loosely tufted, swollen at base, clothed with dark brown, leafy scales at base. Cauline leaf solitary, filiform, almost, bitubular; sheaths auricled. Flower solitary, apparently lateral; lowest bract leafy, up to 1.5 cm long. Perianth subequal, linear - lanceolate, 2.5 - 3.8 mm long, acute, chestnut brown. Stigma-lobes short, cream. Capsules ellipsoid, trigonous.

Fl. & Fr.: July-August.

Specimens examined: Dzongri, *c.* 400 m, ESIK 698 (BSHC,E).

Habitat: Among moss on wet rocks and boulders in alpine zone.

3. **Juncus glaucoturgidus** Noltie, Edinb. J. Bot. 51(2): 132-133.1994.

Herbs. Rhizomes not distinct. Stems densely tufted, up to 25 cm high, sheathed with many straw coloured scale leaves at base. Cauline leafy solitary, subbasal, upto 12 x 3.2 cm, cylindric, hollow, blunt at apex, contracted below at apex, glaucous. Capitula terminal, *c.* 2 cm in diameter, *c.* 12-flowered; involucral bracts subequal, reddish-brown. Perianth subequal, oblong-lanceolate, up to 6.5 x 1.6 mm, outer ones keeled, inner-ones not keeled. Filaments shorter than perianth, anthers narrowly oblong, upto 3.5 mm, pale-yellow, exserted. Stigma-lobes stout, cream. Capsules ellipsoid, *c.* 4.5 x 2.5 mm, golden-brown, beaked.

Fl. & Fr.: July-August.

Specimens examined: Samiti-lake, Bungoteng-cho, *c* 4300 m, ESIK 572 (BSHC, E,K).

Habitat: On open, sandy, calcareous slopes in alpine zone above tree-line.

4. **Juncus hydrophilus** Noltie, Edinb. J.Bot. 51(2): 138.1994.

Herbs. Stolons short, slender, dark brown, clothed with scales and fibrous remains of old scales. Stems loosely tufted, up to 40 cm high, with a leaf-like basal scale. Cauline leaves 3-4, evenly spaced, up to 17 x 0.3 cm; sheaths up to 4 cm long, reddish-brown, without auricles. Inflorescence of a single anthela with 3-4 capitate partial inflorescence. Capitula 4-9 flowered, *c.* 1.5 cm in diameter; lowest bract shorter than inflorescence. Perianth narrowly lanceolate, 3.5-5.3 x 1-1.4 mm, acute, inner slightly larger. Filaments longer than perianth, anthers exserted, narrowly oblong, pale-yellow; stigma-lobes 0.5-1 mm, Capsules narrowly ovoid, *c.* 6 x 1.8 mm, straw coloured.

Fl. & Fr.: July-August.

Specimen examined: Prek-chu bridge below Bakhim, *c.* 2300 m, ESIK 771 (BSHC, E, K).

Habitat: On wet-cliffs in Oak forests.

5. **Juncus nepalicus** Miyam & H.Ohba in J.Jap.Bot. 68: 28-30.1993.

Herbs. Root-stocks woody, rhizomatous. Stems tufted, ascending, slender, striate, up to 20 cm long. Leaves flattened; cauline ones 1-2, linear-lanceolate, up to 2 x 1.5 mm, basal linear up to 12 x 0.2 mm; leaf-sheaths obliquely truncate. Heads 1-2, chestnut brown; lower bracts lanceolate, up to 1.5 x 0.1 cm, brown. Flowers 6-8 x 1.8 -2.2 mm; pedicels upto 2 mm long. Perianth segments ovate-lanceolate, inner slightly longer. Stamens 6, 2.5-3.5 mm long, anthers linear - elliptic; stigma reddish. Capsules ovoid, trigonous, *c.* 4 x 2 mm, deep brown.

Fl. & Fr.: July-August.

Specimen examined: Lachen, 10000 ft, **Hooker, s,n,** dt. 6.7.1849 (K); **Hooker, s.n.** (K) **p.p.**

Habitat: In screes at 3000-4400 m in North Sikkim district.

6. **Juncus perpusillus** Sam. in Hand.- Mazz., Symb. Sin. 7:1237-1238.1936.

Densely tufted, dwarf herbs. Rhizomes short, stout. Stems 1.5-8 cm high. Leaves bitubular, filiform; basal ones with dark purple-brown sheaths; cauline ones sometimes lacking; sheaths with reddish-brown auricles. Capitula 2-4 -flowered; bracts chestnut brown, lowermost exceeding inflorescence. Perianth oblong, up to 4.5 x 1 mm, blunt, white, turning to dark purple. Filaments exceeding perianth, anthers *c.* 2 mm long. Stigma lobes spreading. Capsules oblong-ellipsoid, *c.* 3 x 2 mm, abruptly contracted into beak.

Fl. & Fr.: July-August.

Specimen examined: Above Chunaikiang, near foot of eastern Rathong glacier, *c* 4550 m, ESIK 375 (E).

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I am grateful to the Director, Botanical Survey of India, and Regius Keeper of the Herbaria at RBG, Kew and RBG, Edinburgh, for facilities; to INSA, New Delhi and The Royal Society, London, for the grant of fellowship for visit to British Herbaria; and to Drs. P. Cribb and D.A. Simpson of K and Mr. H. J. Noltie of E herbaria for the help extended during my visit to their herbaria.

November 21, 1995

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Editorial

The study of Ornithology in the Indian Subcontinent has been, up to the very recent decades, the prerogative of the talented amateur. The men who laid the foundations for this study came from various professions. Hume, who could be termed the father of systematic Indian ornithology, was an administrator. Oates, an engineer, and Blanford, a geologist, wrote the first series of volumes on India's avifauna. Baker, who wrote the eight volume second edition on Indian avifauna was in the police force of Assam State. In fact, until the appearance of Sálim Ali on the scene, ornithology in India was very much a preserve of the British official establishment.

It has been suggested that Sálim Ali took up the study of Ornithology as a challenge because an anonymous reviewer of Stuart Baker's Fauna lamented that he had not seen a reference to a single paper written by an Indian in Baker's Bibliography. Nothing could be further from the truth. Sálim Ali was hooked on to birds from the time as a young boy he walked through the portals of the Bombay Natural History Society with a yellowthroated sparrow in his hand, and for the next 69 years, the Society and Sálim Ali lived in a state of mutualism. In the beginning it was Sálim Ali who was dependent on the support of the Society, then the position was reversed when the Society was on the brink of extinction at the time of Independence. Sálim Ali more or less single-handedly resurrected it. In his lifelong association with the BNHS for over 69 years he and the Society became synonymous in the eyes of the world. Finally the Society was his family and all that he cared for in his later years and to it he left whatever he thought was valuable in his possession.

Sálim Ali's association with the *Journal of the Bombay Natural History Society* started in 1927-28 when he functioned briefly as one of the editors. He resumed his connection with the *Journal* in 1944 (Vol. 45), collaborating with S.H. Prater and C. McCann. Upon their leaving India, Sálim Ali took over as General Editor assisted by Dr. S.B. Setna for a year, when Fr. H. Santapau joined the board. He published the results of his ornithological studies more or less exclusively in the *Journal*.

In this commemorative issue we had requested those who had known him as a person, an ornithologist and as a conservationist, as well as his many students to contribute papers. The response has been quite positive, though in some areas especially from those who knew him intimately and from some of his senior students it was disappointing. This *Journal* is a tribute to Sálim Ali's decades of endeavour in the study of the ornithology of the Subcontinent and for the conservation of its natural resources.

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DR. SÁLIM ALI'S CONTRIBUTION TO KUTCH ORNITHOLOGY

M. K. HIMMATSINHJI[1]

The history of ornithology is spread over a long and glorious period in Kutch. At least during the last eight centuries those people who came over into Kutch, mainly from Sind and Rajasthan, settled down and evolved the kutchhi dialect, have taken a keen interest in nature throughout that period. In that almost every species of flora had been named, and all animals along with many of the birds endemic to this region have local kutchhi names. Animal life has been woven into legends, art, as also into prose and poetry. Even some geographical features have been named after animals such as 'sinh jhar' (lion valley) and 'sinh khatlo' (lion hill), to give just two examples. In the case of birds, the name 'hansa' is used for swan and 'hanj' denotes the flamingo. The Gujarati name coined (perhaps in recent years) for the goose is 'hansa', whereas the kutchhi name is 'gaj'.

No wonder the erstwhile rulers of Kutch were naturalists too and some of them took a keen interest in the birdlife of the region. Unfortunately there are no earlier records, and the only written record is that of four generations starting from the early nineteenth century. Maharao Shri Pragmalji II planned to have a Natural History Museum in Bhuj in the first half of the nineteenth century, for which bird specimens were collected. However, he died at an early age and that scheme did not fructify. Maharao Shri Khengarji who succeeded as ruler was also a keen naturalist and bird-lover in whose time documentation of the birds found in Kutch was first undertaken. Both Maharaos Vijayrajji and Madansinhji were naturalists and sportsmen. It was during the reign of the former (1942-48) that Dr. Sálim Ali took up the reins of bird study and surveys in this region. It may be mentioned here for the sake of interest and for the record that the other remarkable ornithologist/naturalist, Humayun Abdulali, had stolen a march over SA in paying a visit to Kutch somewhere in the year 1936 and had contributed a few new bird records for this area.

It would be necessary here to go back into the period of time in order to relate the sequence of events, as also records of birds from the earliest available sources. Apparently the first person to study the fauna of this area was a geologist, Dr. Ferdinand Stoliczka, who made a systematic list of birds he saw and collected from Kutch in the latter part of the 1860s and which were mainly identified by the great A.O. Hume. Stoliczka then published a paper on the mammals and birds of Kutch in the *Journal of the Asiatic Society of Bengal* in 1872. Those who study birds would be interested to learn that the first specimens of *Saxicola macrorhyncha* (Stoliczka's Bush Chat or Whinchat) were collected by him from Kutch and described. The bird has now disappeared from some of its former distributional areas including, perhaps, Kutch.

A.O. Hume also kept a tag on the birds to be seen in Kutch. He appended remarks regarding bird records of this region to a list of birds prepared by Capt. E.A. Butler, stationed at Mt. Abu, and published it in *Stray Feathers* in the years 1875 and 1876. It seems that Butler himself did not visit Kutch more than once or twice. The first edition of THE BIRDS OF KUTCH was prepared by one Mr. Hugh Palin in 1878. He was followed by Capt. C.D. Lester, apparently quite a competent ornithologist, who revised the list of Palin in 1898 and added some more species to his own previous effort before he authored the 2nd edition of THE BIRDS OF KUTCH printed in 1904.

At that period the British Political Agent, his staff and a British Indian unit of the army used to be stationed in Bhuj. Among them were a few birdwatchers who also contributed their observations on the avian occurrences in Kutch. Apart from them, there was that famous chronicler of the birds of British Somaliland, Sir Geoffrey Archer, who spent a number of years in Kutch. He, however, spent most of his time in the Kandla port area, but was able to make some useful observations. Unfortunately, the better part of his bird collections went to museums outside the country, though his collection of eggs was presented to the Bombay Natural History Society.

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[1] Jubilee Ground, Bhuj, Kutch, Gujarat.

Most of the progress in the field of ornithology in Kutch took place in the long reign of Maharao Khengarji whose own greatest achievement was the discovery he made of the Greater Flamingo breeding in the Great Rann of Kutch in 1893. Since then, that breeding colony became a place of pilgrimage for many ornithologists, but it was Dr. Sálim Ali who in the later years made some important discoveries while visiting the Flamingo City, as Charles McCann called the breeding colony.

The object of my giving this rather long preamble in the form of a resume of the history of Kutch ornithology was to show that as in the rest of the Subcontinent, in this region too, much of the initial ground was covered by British officers. When Dr. Sálim Ali came on the scene he started working in right earnest, at times against heavy odds and by the end of his career the pinnacles of achievements he had reached were, if not greater, at least equal to his predecessors. He never hesitated in appreciating the talents or good points or the expertise of anyone. Apart from those who taught and guided him in the initial stages of his career, he even kept in touch with experts such as Hugh Whistler and others and sought their opinions from time to time on points of ornithological interest. When he was invited by Maharao Vijayrajji to come to Kutch and prepare a fresh account of the birds of Kutch in 1943, he took up the assignment with the greatest of enthusiasm and earnestness. The Kutch State did not spare any effort or expense in facilitating the full and detailed survey of the area.

Now Dr. Sálim Ali realised the usefulness of Lester's THE BIRDS OF KUTCH which he was to update, and which he used as his checklist. Thus began the survey which was undertaken between 1943-1944. Those were the peak years of the Second World War, with many commodities, particularly petrol, in short supply. The jeep had not come into civilian use and the rather large area of Kutch in those days had to be traversed by the good old convertible Ford, the best means of negotiating sandy tracts and bullock cart tracks in which the vehicle often used to get stuck and had to be pushed across through manpower! Where the car could not go the ubiquitous bullock cart or camel always came in use. As was his wont Dr. Sálim Ali kept meticulous notes and never failed to collect specimens during his field trips. Here again, owing to the war he had to face some handicaps, the chief among these was the unavailability of the collections abroad for comparative study as they were packed away and dispersed for safety at that time. But undaunted by these hurdles which for SA were minor, he went ahead and completed the revised new edition of THE BIRDS OF KUTCH which even today is an extremely useful field guide for the region. During the survey it became very clear to the great ornithologist that Kutch was an important area from the point of view of bird study, not only because of the speciality of some endemic species, but more so as it lay on the route of many of the migrating birds which come into India to spend the winter and return at the beginning of spring every year. In his Introduction to THE BIRDS OF KUTCH (1945) Dr. Sálim Ali mentions: "But the chief interest of Kutch ornithology lies in the geographical position of this narrow strip of land relative to the mighty tide of migration that sweeps into India from beyond its northern and north-western boundaries... Apart from the migrants that come to spend the winter... the area is of further importance in that it lies on the extreme eastern fringe of a broad stream of through migration that flows down from Central and Northern Asia in a south-westerly direction...". He followed this up at the earliest opportunity he got for organizing a bird-ringing camp in Kutch which was followed by others at some intervals of time. Bird netting and ringing provided very important and interesting information on bird species and their migration and on the movements of the endemic birds also. A few new species were added to the then existing list. It was believed till then that the Great Rann of Kutch acted as a barrier against the movement of resident species between Kutch and Sind. The ringing programmes at least partially showed that this was not so.

There are several big and small islands situated in the Great Rann which are formed by silt and have some vegetation and a good growth of grass on them, and so the insect life also subsists there. In view of this fact, birds such as the larks, house sparrow (these are commonly seen on BSF posts), doves and bee-eaters could easily stop over on these islands and go across into Sind (Pakistan), and *vice versa.* In the case of *Merops orientalis,* it is likely that wider investigation may reveal the presence of the paler race *beludschicus* in Kutch.

Dr. Sálim Ali's contribution to Kutch ornithology is so valuable that no words can adequately describe it. He possessed an uncanny quality of recognizing talent and knowledge in persons and his chief aim was always to serve the cause of the Bombay Natural History Society. SA's other remarkable attribute was to develop an acquaintance into friendship and partnership. There were quite a few examples of this, but prominent among them were two wartime acquaintances. One was W.T. Loke who had come away to India in the wake of the Japanese occupation of the then British colony of Malaya. Loke accompanied Dr. Sálim Ali during the Kutch survey. SA had this to say about it: "I would like to express my thanks to W.T. Loke (of Malaya) who accompanied me throughout the Kutch survey, and was such a help both in the field and later in the museum. His enthusiasm for birds and proficiency with the camera have combined to produce some of the beautiful photographs that illustrate THE BIRDS OF KUTCH, 1945. This was the beginning of the benefits that followed, to Indian ornithology in general and to the BNHS in particular, through this friendship till the untimely death of Loke.

The other example of friendship developed by the great SA goes beyond the limited field of Kutch ornithology and entered a far wider scope in the history of Indian ornithology. This was the partnership of Dr. Sálim Ali with Dr. S. Dillon Ripley II, which was instrumental in the publication of that monumental work of Indian ornithology, THE HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN along with Dr. Ripley's most useful A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN and of course the other works. Thus a long felt need for the replacement of older works such as those of E.C. Stuart Baker could be fulfilled.

Coming back to the main subject, the keen sense of perception, planning and marvellous anticipation of the great naturalist all combined, resulted in the furtherance of the cause of Indian ornithology and conservation of nature in general. Kutch also got the benefit of this. The most important Bird Migration Study Project carried out at Chhari Dhandh as also the Grasslands Ecology Project in the Banni which were undertaken after his passing away were actually the residue of the targets set by him for further research. One could only hope and desire that those concerned would take up the thread from where he left it and make good the targets set by Dr. Sálim Ali for the future of Indian Ornithology and Conservation.

SÁLIM ALI

Lady Y.P. McNeice[1]

It was as refugees from the Japanese occupation of Singapore that my mother and I, together with my brother, Loke Wan Tho, arrived in Bombay in 1942 which led in the succeeding three-and-a-half years to our friendship with Dr. Sálim Ali, a friendship that deepened over the years even after we had left India. It became a profound love for and appreciation of this truly remarkable man.

Originally, it was an article on bird watching, written for a Forces publication by my brother during his stay in India, which attracted the attention of his former school master, Mr Gibson, who was then teaching in Ajmer College. Mr Gibson introduced Wan Tho to Sálim and this was the beginning of a deep and fruitful period of mutual communion in their sharing of the Joys of Nature.

The gap of some 30 years between their ages was insignificant, as their characters blended to a consistency which Sálim's ageless enthusiasm was able to match with the great respect with which Wan Tho regarded him. The common bond which drew these two men together was a love of birds. This, together with Sálim's great knowledge of ornithology and Wan Tho's talent for photography, made it a perfect combination. Moreover, both possessed a keen sense of humour, were quick in repartee and therefore enjoyed each other's company to the full.

Sálim visited me and my husband a number of times; both in our house in Singapore and at our holiday home at Fraser's Hill in Malaysia. Sálim marvelled at the thickness of our jungle compared with the light forest areas in India. (Having visited Bharatpur and Ranthambore myself, I can understand what he meant). Bird watching can be exasperating in Malaysia, for birds are more easily heard than seen, and even more so for those that frequent the upper canopy of our jungle.

I have also happy memories of a safari in Africa on which he accompanied us, when he was able to make comparisons between the wildlife of Africa and that of his own country. At various lodges where we stayed, fellow naturalists from other parts of the world would come up and greet him. Such was the fame and affection that his personality had inspired. On our last evening in Africa, Sálim, anxious to see ever more of the wildlife, urged our guide to go further into the bush. We eventually found that our vehicle had got bogged down in the soft sand. It was then "all hands" to try and extricate ourselves, gathering any brushwood that we could find. One of us kept a lookout and, to our horror, we saw a rhinoceros not far away. There was a small bush between him and us. As we know, the rhinoceros has poor eyesight but a keen sense of smell. However, luck was on our side and after some extremely anxious moments, our vehicle managed to break free and all of us heaved tremendous sighs of relief!

These are our own particular memories of the great man, Sálim Ali, to which I would like to add the name of his kindred spirit, my brother, Loke Wan Tho.

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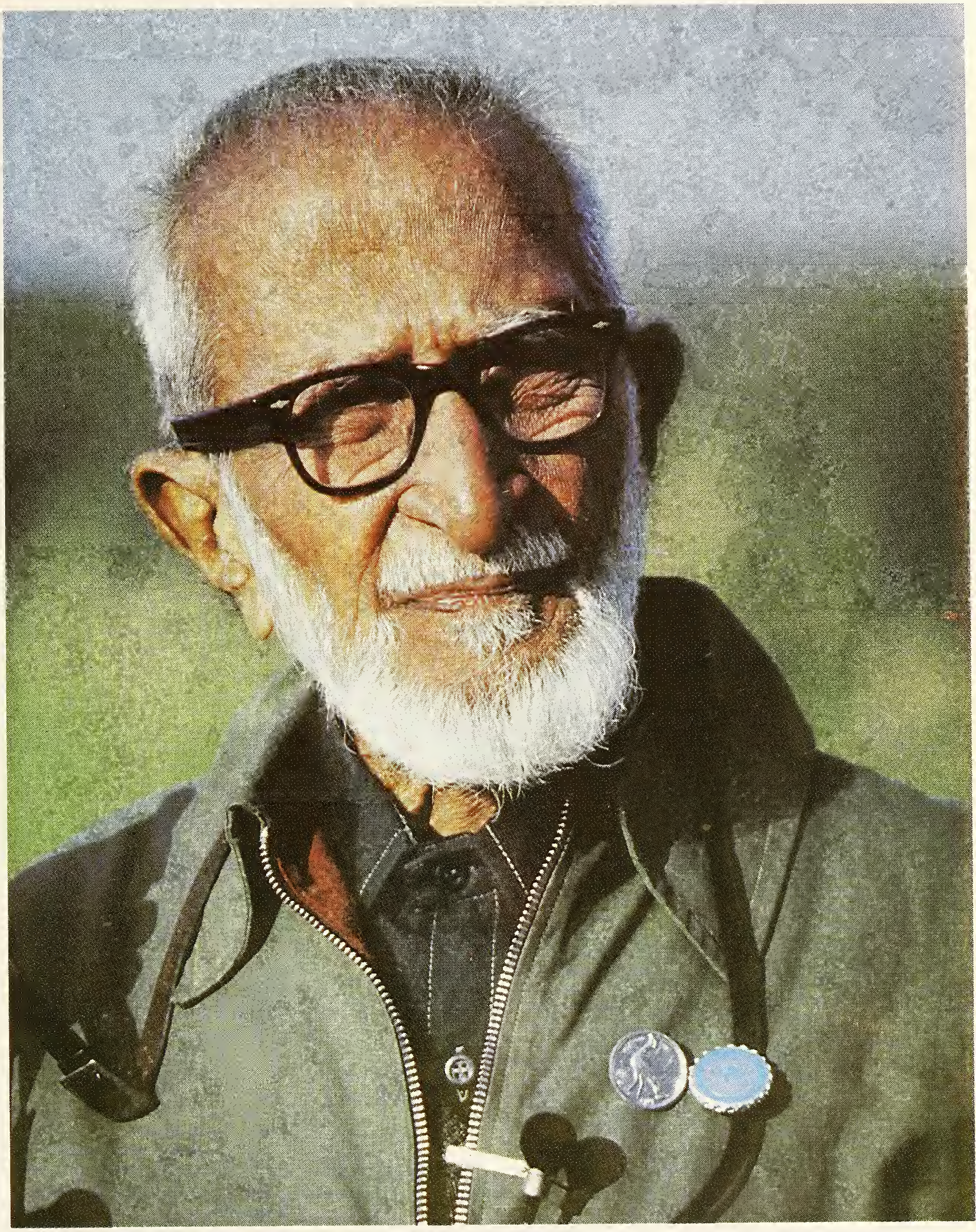
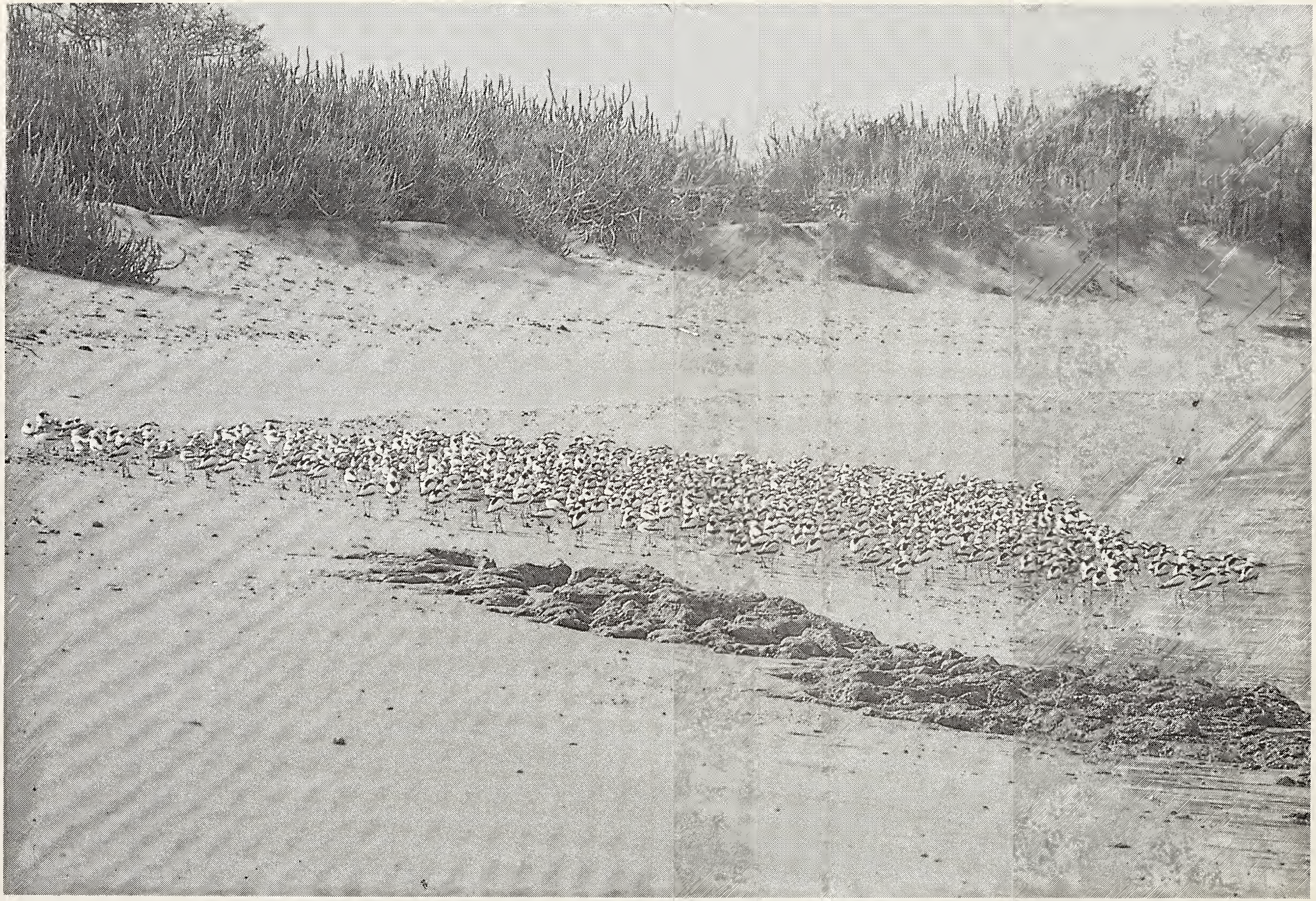


PADMA VIBHUSHAN DR. SÁLIM ALI

1896-1987



A flock of Crab Plovers at Beyt

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THE BIRDS OF GUJARAT - A SALIM ALI CENTENARY YEAR OVERVIEW

Lavkumar Khacher[1]

(*With a plate and a map*)

Introduction

The late Dr. Sálim Ali had undertaken field surveys of what is today the Gujarat State in pre-independence years, largely at the invitation of some of the Princely States of Kachchh, Vadodara, Radhanpur, Palanpur, Khambhat and Rajpipla. Collections were also made in the forest rich tribal area of the Dangs. These surveys had Sálim in the field "for varying periods of a month to five months at a time between the years 1944 and 1946 with shorter field trips up to 1948." The Kathiawar peninsula, today known as Saurashtra, was partially covered, thanks to several "Gaekwadi" territories which touched on to the Gir forest and the southern part of the Gulf of Kachchh in what is known as Okha Mandal, today a taluka of the Jamnagar district. Fortunately, the Kathiawar region was intensively "birded" by several, very keen naturalist families of which mine of Jasdan was one. To our south, the Bhavnagar State was fully covered by the three royal brothers Maharaol Krishnakumarsinhji, Nirmalkumarsinhji and Dharmakumarsinhji. What this sporting trio missed was hardly worth recording. My cousin, the late Shivrajkumar Khachar and I were guided into high level birdwatching by the Bhavnagar "Gurus" — their seasonal visits to Hingolgadh and our return forays to the Bhavnagar seaboard were momentous occasions. To our north was Wankaner with an actively knowledgeable sporting family and much of today's Jamnagar district was the hunting ground of the Jam Sahebs of Nawanagar. The outcome of all this active interest in birds produced two well illustrated books: THE BIRDS OF KUTCH by Sálim Ali and THE BIRDS OF SAURASHTRA by Dharmakumarsinhji. All these and several other princes were members of the Bombay Natural History Society. In addition, there were several "commoners" who either developed an interest in birds through their association with their feudal employers or who had developed an interest entirely on their own; among these mention must be made of the following stalwarts: Harinarayan Acharya, Manubhai Jodhani, Niranjan Varma, Jaymal Parmar, Pradyumna Desai, Vijaygupta Mauriya, Chhotubhai Sutar, Haribhai Chauhan and the poet Dinkarray Vaidya. These men must be saluted since they all have contributed in moulding contemporary attitudes towards birds by their popular writings in Gujarati. Pradyumna Desai was an artist of considerable talent.

Salim Ali renewed his active association with the newly established Gujarat State when BNHS started mistnet captures of birds for banding; Kachchh was his first choice. The netting operations were later started at Hingolgadh in Saurashtra and the ornithologist established a close and affectionate association with birdwatchers of Saurashtra, Lalsinh

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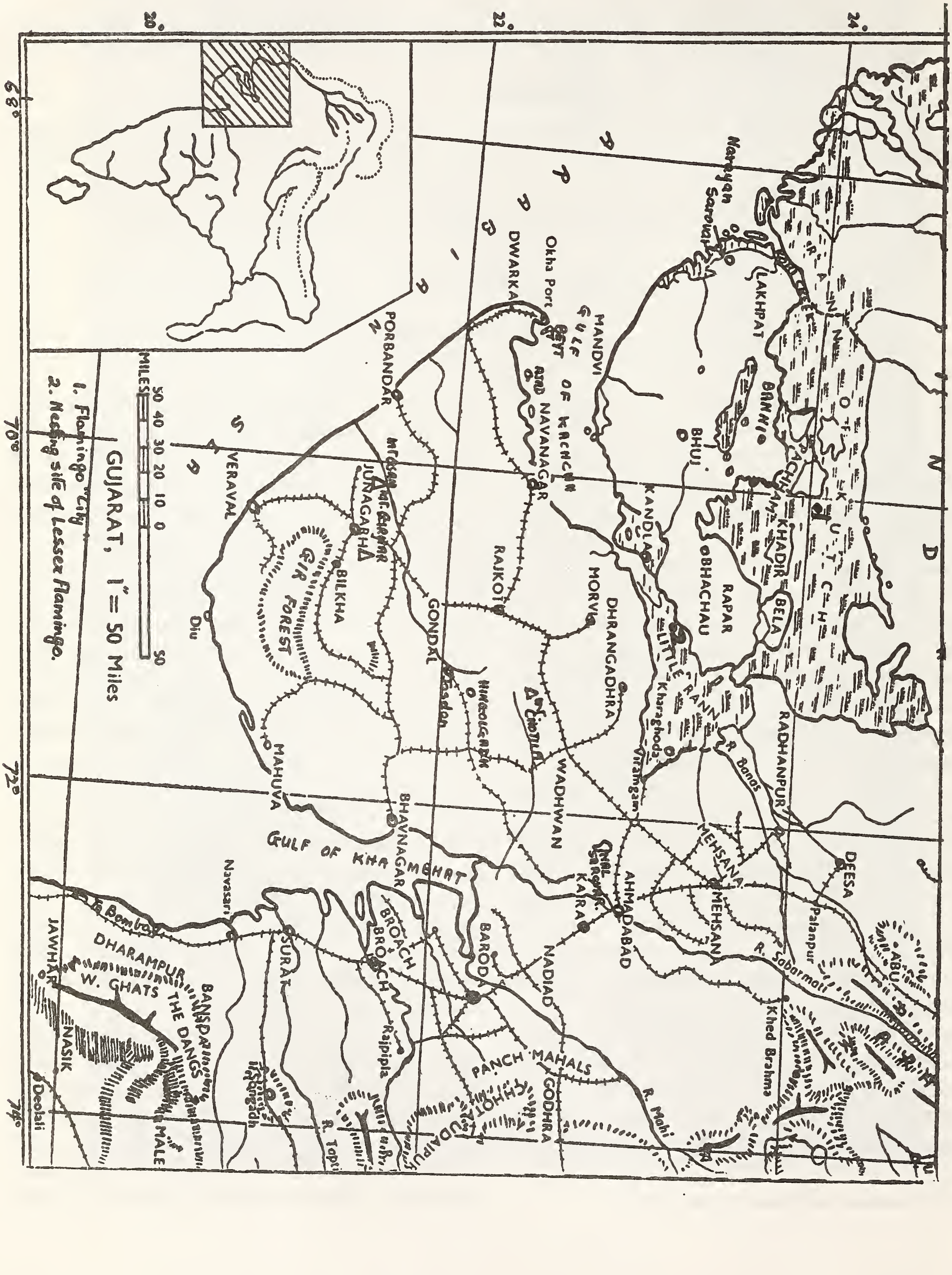
[1] 646, Vastunirman, Gandhinagar, Gujarat 382022.


GUJARAT, 1" = 50 Miles
MILES 50 40 30 20 10 0 50
1. Flamingo City
2. Nesting site of Lesser Flamingo.
20°
22°
24°
68°
70°
72°
74°
A R A B I A N S E A
R A N N O F K U T C H
I N D
Narayan Sarovar
LAKHPAT
BANNI
BHUJ
MANDVI
KANDLA
KHADIR
BELA
RAPAR
BHACHAU
LITTLE RANN
Kharaghoda
RADHANPUR
R. Banas
DEESA
Palanpur
R. Sabarmati
ABU
Khed Brahma
MEHSANA
Viramgam
AHMADABAD
KAIRA
NADIAD
BARODA
GODHRA
PANCH MAHALS
CHHOTA UDAIPUR
R. Mahi
BROACH
Rajpipla
SURAT
R. Tapti
Navsari
Bombay
DHARAMPUR
BANSDA
THE DANGS
W. GHATS
JAWHAR
NASIK
Deolali
MALE
GULF OF KHAMBHAT
BHAVNAGAR
MAHUVA
Diu
VERAVAL
GIR FOREST
BILKHA
JUNAGADH
GONDAL
RAJKOT
MORVI
DHRANGADHRA
WADHWAN
NAVANAGAR
GULF OF KACHCHH
BET
Okha Port
DWARKA
PORBANDAR

Raol particularly impressed him and K.P. Jadav's bird drawings delighted him. Gujarat continues to have a fairly large number of amateur birdwatchers and it is hoped that through this article concern for the active conservation of the region's still dramatically visible birdlife will be rekindled and that the Society will see the importance of once again exploiting the immense potential within the State. Without popular concern, the trends forewarned by Sálim Ali in 1954 and continually harped on by others including myself will never be halted.

Lalsinh Raol has written extremely readable books in Gujarati which have used standardised birdnames in the vernacular, and a checklist of the birds of Gujarat was updated by him and myself. Considerable new information had been accumulated by bioscience students of the Saurashtra University, Rajkot, where the late Prof. R.M. Naik gave our interest a scientific aura. Notable among the young men who acquired scientific credentials at the University are Bhavbhuti Parasaria who has to his credit qualitative research on egrets and herons, and Taej Mundkur who streaked like a meteor across Saurashtra's ornithological firmament to rekindle the waning enthusiasm among those of us from yesteryear. Today, there are knowledgeable amateur groups in Bhuj lead by MKS Himmatsinhji, and in Bhavnagar encouraged by MKS Shivbhadrasinhji. There are competent amateurs in Jamnagar, Ahmedabad, Baroda and Surat. Hingolgadh continues to be a rallying point for naturalists. We may yet be able to generate a powerful popular commitment for the conservation of Gujarat's birdlife. Unless quality programmes are taken on in the next few years, Sálim Ali's warning: "Conditions affecting wildlife in general, directly or indirectly, have changed and are changing rapidly, and unhappily not for the better", in Part I of his paper, The Birds of Gujarat (JBNHS Aug.-Dec. 1954) may well be the understatement of the century! We have, for all practical purposes, lost the Great Indian Bustard. Other species are in precarious situations. In the 1940s birdlife was plentiful and confiding, particularly so in the regions of Kachchh, Kathiawar — present day Saurashtra, and the densely populated and intensely cultivated "champaigns" of mainland Gujarat. This was on account of the basic sentiments of the people strongly influenced by the Jain and Vaishnava repugnance for taking life, and a land based economy which encouraged care of the land, be it for agriculture, grazing, or growth of grass or trees. Technological limitations prevented over-exploitation and this created a happy situation of what we today hear so frequently talked about in environment circles — "Sustainable use of natural resources". Social restrictions were enforceable in the mileau of the times and birdlife throve. True, there were pockets of poorly managed and even in those times over-exploited lands, but they added habitat variety — considerable areas were overgrazed, poorly farmed and degraded, and there were communities which surreptitiously killed against the popular sentiments. Their impact, however, was low though they were the seeds of much of what we see today. With the advent of democracy what had tended to be discreet came out into the open and paradoxically, because of the still existing strong sentiments against the taking of life, there has emerged no powerful, legally empowered hunting lobby capable of enforcing regulations. Livestock owners, who were always a problem, were emboldened, often encouraged by political opportunism to circumvent restraints on entry into grass preserves, most of which very quickly merged into the surrounding overgrazed common lands. Trees, whether they were on hills, along water courses or forming avenues were mercilessly lopped by goatherds, and felled by fuel gatherers. Kachchh suffered the most, with an active charcoal mafia exploiting ancient stands of *Acacia nilotica*. Waterbodies which had been largely sacrosanct were netted for the first time, and despite setting up of Wildlife Advisory Boards and promulgating wildlife laws there evolved no effective means of restraint in a democratic dispensation. Wildlife, particularly the more visible, rapidly declined.

If the direct assault on wildlife had done considerable damage and continues to do so even today, it is a set of indirect effects which today threatens to produce an almost total collapse. What set these into motion needs to be examined if we are to prevent the extinction of most of our birds and other animals. Since most of the developments were initiated for the betterment of the general population and considerable gains have accrued, many of those wanting to halt the processes find themselves isolated. Issues tend to be separated into those involving human welfare versus those for wildlife. The same refrain was heard in the late forties by political and social activists is today carried forward by the more aggressive, more powerful "development" lobby with the political leadership invariably responding to populist appeals.

Fortunately, though it has taken time, the general public has begun to realise that issues are not trees and animals against human beings, but that they involve groups aiming for highly personal gains at the cost of social benefits, and that efforts are aimed at quick short term gains, heedless of long term losses, and at highly exploitative economics contra sustainable utilisation of resources. Public debates are on and it will suffice here merely to highlight a few basic issues:

1. **Agriculture**: The shift to largely single crop cultivation has destroyed the diversity of niches within agricultural lands. Intensive agricultural practices have destroyed hedgerows and obliterated grass verges. Significantly, this practice was encouraged as pest control action! Spraying of pesticides (on several occasions by low flying airplanes) has created havoc. Hard sell advertising has resulted in an almost compulsive use of inorganic fertilisers. After World War II there had been drives to eradicate mosquitoes and rats — rodent poisons and DDT which poisoned the biosphere were dumped on to an unsuspecting population. These processes, though now banned in more perceptive societies are still practised, if not actively encouraged, in India and continue to weaken the biological dynamics. Both insectivorous birds and raptors have registered a very significant decline.

2. **The Wetlands:** Village tanks were traditionally central to the community and considerable tacit restraint was enforced to permit a varied use. Invariably, killing of birds and fishing was not countenanced. Birdlife was particularly plentiful and diverse, as well as absurdly confiding. Pulsating communal nesting colonies of ciconiids and cormorants existed everywhere and Sarus bred fearlessly throughout the region. Unhappily, with water being supplied by taps, community concerns diminished and with overall authority weakening, today most wetlands, like other common lands, are under intense pressure. Many are being encroached upon for cultivation or being used as dumping sites near urban centres. The peripheral trees are mutilated for fodder and bark peeled off to kill the trees so as to circumvent laws against felling live trees! Most of the nesting colonies have gone. Several of the larger tanks are leased out by the authorities for fishing and the former sentimental proscriptions are dying out. Reed beds are cut by marginalised communities for thatching. More insidious, however, is the poisoning of the water by greater quantities of detergents and sewage inflows, and the draining in of pesticides and inorganic fertilizers from surrounding agriculture. Tidal forests have been almost wiped out.

3. **Forestry Practices:** Prior to the merger of the States, Wildlife fell under the purview of Shikar Departments. Where the landed gentry lacked shikar compulsions, wildlife cared for itself, protected by and large by popular sentiment. There was, however, a lively awareness of wildlife which is common to all people living close to the land. Some of the finest wildlife caretakers were from communities which also had traditions of snaring birds and small mammals. Such men often enjoyed a considerable reputation, their almost instinctive knowledge of the wilderness being highly appreciated. In north Gujarat, Kachchh and Saurashtra there were Grass Departments enjoined to care for grasslands (*Vidis* in Kathiawar and *Rakhals* in Kachchh) from where grass was extracted as a valuable resource. Avenue trees fell within the purview of the authority charged with road maintenance — some of the major roads were shaded by magnificent, large, evergreen trees dominated by *Ficus* sp.

With the merger of the newly formed Saurashtra State and Kachchh into the bilingual

Bombay State an omnibus Forest Department took over grasslands, roadside plantations and wildlife. Grass became a "minor forest produce" and beautiful grasslands which had acquired characteristic biological communities seemed an affront to the forester's eyes! Roadside avenues became extensions of forestry plantations. Down the decades the Forest Department, unable to adjust to the changed political scenario, found its role in the democratic situation quite like a tightrope walk. The resultant conflicts have still not been resolved. In any case, we find a penchant for favouring quick growing exotics and nonbrowse species almost to the exclusion of all others. Despite the very notable efforts of a few officers, the Department which professionally is the guardian of biodiversity remains quite confused. There are indications of younger officers who are thinking ahead of their times and there is indeed hope of a renaissance in wildlife management involving the people. Unhappily, vast areas have been overgrown by *Prosopis chilensis*, thanks not so much to the tree's great capacity, but to its aggressive propagation by the Department and on account of the continued assault by fuel gatherers and domestic stock on native species. Birdlife has suffered. We have lost the Great Indian Bustard.

4. **Industrialisation:** Much of Gujarat's industrial development has had a direct as well as indirect adverse effect on the environment in general and birdlife in particular. The need for lift irrigation, particularly in the Saurashtra region encouraged the vigorous manufacturing of diesel engines and pumps in the small scale industries and an intensive marketing drive within the area that resulted in overdrawing of water from rivers and subsoil aquifers. All watercourses today have totally dried up and former perennial river pools and their reedbeds have disappeared. The widespread use of pesticides and inorganic fertilisers has already been referred to. A great majority of the more profitable industries are manufacturing detergents, chemicals and dyes, all of which are produced by processes which are banned in industrially advanced countries. The end products are, however, in demand there, hence the profitability. Rivers and depressions carry large quantities of toxic effluents along with untreated sewage from growing urban centres, of which aquatic life has borne the brunt. River Terns, Blackbellied Terns, Pied Kingfishers, Little Cormorants and Darters have all but disappeared. What impact the larger petrochemical and cement units are likely to have on birds is a matter of conjecture. Strategies will have to be worked out to diffuse their impact. To conclude, the situation cannot be worse. The protagonists of "man first, everything else after" have done their worst. Already environmental degradation is adversely affecting human beings and there is public concern. The ancient values for life are fortunately alive and the band of dedicated birdwatchers is vigorous, more youthful and fortunately less apologetic in advancing the cause. There need be no more losses if some qualitative and highly imaginative programmes are undertaken. Birds are still very visible and confiding; Gujarat is a major centre for wintering cranes, the Sarus are still common and loved, peafowl are plentiful and confiding almost everywhere; Jamnagar's Ranmal Lake is a marvellous bird sanctuary and Bhavnagar's Victoria Park and Pele Gardens are pulsating waterbird nesting sites; around Ahmedabad there is a large number of village tanks where stork colonies thrive; flamingoes of both species regularly nest in the Ranns; in the Gulf of Kachchh there are coral and mangrove islands that are largely undisturbed, with thriving colonies of egrets, herons and darters; the tidal mudflats draw teeming flocks of Palaearctic waders — each autumn flocks of birds pass over down the Indus flyway to peninsular India or to Arabia and East Africa. Gujarat remains a major avian area of the world. Bird enthusiasts need to articulate their concerns and work in cooperation on projects which would arouse popular interest.

PHYSIOGRAPHY

In part I of his paper, "The Birds of Gujarat", Sálim Ali very succinctly outlines the great diversity of Gujarat's biotopes ranging as they do, in his language, "from practically pure sandy desert (e.g.

the Great Rann of Kutch) with an annual rainfall of less than 10 inches, to tropical semi-evergreen forest (e.g. portions of Navsari district and the Surat Dangs) with an annual precipitation of over 80 inches". It may be noted that both the Great and the Little Rann of Kachchh are not sandy deserts, in fact they are not deserts in the accepted sense as are the Thar Desert of Jaisalmer, Rajasthan or the Sahara — they are vast, flat saltpans often glistening like a Polar sea when salt encrustation is maximum; at other times they are vast stretches of blue, highly saline water, a period when their lifeless expanses start pulsating with life. Understanding this Dr. Jekyll and Mr. Hyde character of the Ranns would make it possible to ensure that there is no confrontation between the needs of salt industries and of wildlife. As a matter of fact, the danger of denotification of the Little Rann of Kachchh as a wildlife sanctuary is emanating from this very absence of understanding. Also, few naturalists seem to be alive to the fact that the rainfall whether averaging less than 10" or topping 80" per annum is caused under the influence of the SW monsoon with most of the precipitation occurring between June end and September. The rest of the year is a long drought. Also not appreciated is that rainfall fluctuations are considerable and particularly so in Kachchh, with some of the heaviest downpours experienced anywhere in the subcontinent. Wind velocities during the height of both the monsoons are very high over Saurashtra and Kachchh, generating a correspondingly intense rate of evaporation. Knowledge and awareness of these factors would make reforestation efforts significantly different here than elsewhere. Success or failure in revegetating the land on a qualitative basis will determine the survival of Gujarat's avifauna.

The two Gulfs of Kachchh and Khambhat have not been adequately recognised, nor are their differences sufficiently highlighted before. Both Gulfs are tapering in and as such, experience great tidal rise and fall at their heads, creating wide tidal mudflats eminently suited for the teeming multitudes of northern shore birds, and for the flamingoes. Both the Gulfs were fringed by excellent mangrove forests, themselves unique bird habitats on account of the rich detritus generated for marine life, and in providing roosting and nesting sites for herons, egrets, spoonbills, ibises, cormorants and darters. There is, however, a significant difference in that the Gulf of Khambhat is highly turbid on account of large rivers flowing into it — the estuaries of Sabarmati, Mahe, Narmada and Tapti permit inflow of tidal influence far into the alluvial plains, thus interlacing with saline habitats the vast plains to the west and south of Ahmedabad which are themselves converted into, quoting Sálim Ali" ... a chain of marshy jheels ... attracting abundant wildfowl". The Nal Sarovar is perhaps the most well known of the brackish water lakes. There are a host of freshwater jheels notably Kanhewal, Narda, Pariej, etc., all creating a rich mosaic of wetlands. The Gulf of Kachchh wedged between Saurashtra to the south and Kachchh to the north has no large river flowing in. Tides are high, there are immense mudflats equally attractive to shore birds, but the waters are clear and there are coral and mangrove islands along the sheltered Saurashtra coast. Much mangrove vegetation still exists on the outlying islands and several important heronries exist. The Gulf of Kachchh at its head extends on to tidal flats which merge with the expanses of the Little Rann of Kachchh. Seasonally powerful winds drive sea water into the Little Rann as they do up the Kori Creek on the west of Kachchh on to the Great Rann; the Gulf and the Ranns are thus interlinked systems of great biological significance. The Ranns imperceptibly rise on the edges to form grasslands and sedge marshes, the largest of which is the famous range land of Banni. In the not too great antiquity, Saurashtra and Kachchh were islands and the Ranns were shallow inland seas with tides washing up from both the Gulfs to mingle in the Little Rann. The entire complex of shallow seas, salt pans, tidal mud, coral reefs and mangrove jungles fringed by typha marshes and extensive waterlogged depressions into which fresh water collects during the rains creates an amazingly rich bird paradise terminal to the great alluvial plain of the Indus. We have here a nodal area of considerable importance for migrating birds. In his inimitable language Sálim Ali stated thus: "The geographical position of Kutch, Banaskantha and the Kathiawar peninsula and the natural conditions that obtain ... make them ideal venues for the study of Indian bird migration". He goes on to mention that Kachchh "lies athwart the main route of the hordes of species that sweep into India from the north and northwest in autumn and out in the reverse direction in spring." This massed avian transit is still visible, unhappily less so among raptors and some passerines but with undiminished numbers where waders are concerned. The region also has migrants from Central Asia to Arabia and East Africa passing through mainly during autumn. These are passage migrants teeming for a month or so in October, to be gone by mid November, demonstrating marvellously how birds optimise the rich availability of food after the monsoon rains; the same birds, however, return to Central Asia presumably by the Red Sea and across Iraq. In doing so they benefit from a food source generated by winter rains in those areas; in any case, they are not seen in our area on their return migration. The large number of amateur birdwatchers in Gujarat are raring to help in manning observation posts "... strung out along the northern base of the transverse range of hills ..." from Kuar Beyt in the west to Bela in the east, overlooking the flat Great Rann to the north. What could not be achieved in the feudal age may well happen under a democratic dispensation, field ornithology in India will indeed "come into its own".

If the Ranns, the two Gulfs with their tidal flats, mangrove marshes and fresh water jheels have tended to be dramatised as bird habitats of Gujarat, the undulating plateaux and volcanic extrusions of Kachchh and Saurashtra are equally important biotopes with their valuable grasslands, thorn and dry deciduous forests. Along the eastern boundary of the State are outcrops of the Aravalli range and the eroded escarpments of Mewar in the north and of the Malwa plateau to the east. Still further south beyond the rift valley down which flows the Narmada, draining water from the heartland of central India, are the outliers of the Satpura mountains looming above Rajpipla. Good moist deciduous forest still exists, with a delightful bird population. The valley of the Tapti separates the Rajpipla hills from the escarpments overlooking the Dangs which are the northernmost reach of the dramatic Sahyadris of Maharashtra. The higher rainfall supports moist deciduous forests which harbour forest species of the wetter tropical forests of southeast Asia. The rivers and streams of Saurashtra and eastern Gujarat were shaded by evergreen forest corridors which, in years gone by, formed a network amidst drier situations producing an unique intermingling of forest species with those of savannah and thorn jungles. It is of utmost importance to ensure that this biodiversity is protected by highly qualitative afforestation programmes which can best be achieved by encouraging natural regeneration as against the highly manipulative plantation drives. Management of grasslands and wetlands needs to be strongly emphasised. The story of the Great Indian Bustard should not be repeated with other species. Paradoxically, the peoples' needs and those of the birds converge, and herein lies our hope.

... AND THE BIRDS

Apart from the highly visible and confiding birdlife of Gujarat, and the area's nodal position on a major migratory route as already referred to, the great diversity of habitats resulting from the geomorphology and the fact that the region is wedged, as it were, between the deserts of Sindh and Rajasthan which themselves are extensions of the Saharo-Arabian system, and the Indo-Oriental plateaux of peninsular India, Gujarat has a very diverse composition floristically and hence avian. Careless or thoughtless damage to the ecosystems of the region resulting from various human actions would mean the loss of some important bird species. In the Dangs and the Rajpipla hills we have the already doubtful existence of the Forest Spotted Owlet *Athene blewitti*. The Heartspotted Woodpecker *Hemicircus canente* and the Great Black Woodpecker *Dryocopus javensis* may well be lost if favoured forest remnants are cleared or further degraded. The endemic Whitewinged Black Tit

Parus nuchalis which favours thorn and *Salvadora* forests of Kachchh and adjacent north Gujarat has suffered a shrinking of its already circumscribed range, thanks to the spread of alien species. Neglect of and faulty afforestation drives in grasslands has placed the Lesser Florican *Sypheotides indica* in a precarious situation in its major breeding areas of Saurashtra. Gujarat enjoys the responsibility of conserving the largest nesting location of the Flamingo *Phoenicopterus roseus* in the world and the only nesting sites of the Lesser Flamingo *Phoeniconaias minor* outside Africa; any thoughtless development in these hitherto largely undisturbed areas might mean a major ornithological disaster.

Pollution of rivers and waterbodies and destruction of *Acacia* trees around village reservoirs have wiped out hundreds of communal nesting sites of herons, egrets, spoonbill, ibis and cormorants. The world's largest population of the Darter *Anhinga rufa* continues to survive on the coral and mangrove islands off the Jamnagar coast of the Gulf of Kachchh; this population along with vigorous nesting communities of the Grey Heron *Ardea cinerea*, Large Egret *A. alba*, and the Smaller Egret *Egretta intermedia* depend heavily on the few mangrove groves for their continued reproduction. The once commonly widespread Little Egret *Egretta garzetta* has lost most of its inland nesting sites and we may well lose this species as it has of late been reported to interbreed with the Reef Heron *E. gularis* of the coasts. Saurashtra is a major wintering area of the Demoiselle Crane *Anthropoides virgo*, while the saline grassland verges of the estuaries and the Ranns are important wintering areas for the Common Crane *Grus grus*, already, the planting of *Prosopis chilensis* on these valuable crane habitats is causing concern. The intensely cultivated plains of Mehsana, Ahmedabad and Kheda are the stronghold of the Sarus Crane *Grus antigone*. Unhappily, breeding failures are causing concern. Birds of prey have, as has already been indicated, shown a dramatic decline. The reasons are manifold, but if the huge concentrations of wintering harriers in the Velavadar National Park are any indication, habitat damage is one of the main reasons.

Having given a rather generalised idea of the present scenario which may appear rather alarmist, let me hasten to reiterate that Gujarat still continues to be a major avian region of the world. Birdwatchers visiting us invariably go away with excitement as indeed did Sálim Ali on his last visit to Saurashtra where, for the first time he saw Crab Plovers *Dromas ardeola* in flocks of hundreds. In the report on his surveys he has this to say for this attractive bird "Not met with by the Surveys, and apparently a very rare vagrant". In fact, during his "rediscovery" of Kachchh and Saurashtra with the starting of mistnetting, a considerable amount of interesting new information emerged and several new additions were made to Gujarat's bird list. We await the publication of the considerable data accumulated in the sixties and seventies.

This paper concludes by enumerating each avian family with specific comments on the conservation problems of the group. A systematic list is not attempted; Gujarat's Checklist is available with standardised vernacular names. Sálim Ali, who embarked on his tryst with birds by using a systematic listing which started with Crows and ended with Divers (in the case of Gujarat it would be the Grebes) went to considerable pains to explain why in his 1954 paper he had reversed the order. In the intervening years, placement of bird families has once again undergone a further reshuffling so that we now end with the finches instead of the crows! This arrangement was adopted by Dr. Dillon Ripley in the SYNOPSIS as also it appears in the HANDBOOK OF BIRDS OF INDIA AND PAKISTAN and A PICTORIAL GUIDE TO THE BIRDS OF THE INDIAN SUBCONTINENT; this arrangement is followed here. Almost half a century after Sálim Ali's collection forays into the region, we are poised in a scenario which may well result in a great many deletions from Gujarat's checklist. I consider it appropriate that a loud and clear warning goes out in this, his Centenary Year.

CONSERVATION NEEDS — A SYSTEMATIC APPRAISAL

An appraisal of conservation needs of birds has been made at specific levels. We know the reasons for the extirpation of the Great Indian Bustard; there was no need for this to have happened. Scientific studies by ornithologists of the Lesser Florican substantiate what we have all been warning against and, demonstrating forcefully that the degradation of grasslands has damaged Gujarat's agrarian economy — the florican's needs are the same as those of human beings. The quality of the environment is at stake and birds, in their varied niches, are excellent indicators of environmental quality. In attempting to provide niches for different birds we may well enrich the human environment and enhance our quality of life.

Family GAVIIDAE: Loons and Divers

Vagrant to the subcontinent as winter visitors, however, their essentially marine habitat during the non-breeding winter months makes their possibility greater off our seaboard. Overfishing and oil slicks pose major threats.

Family PODICIPEDIDAE: Grebes

Of the four species of Grebes on the Indian List, in the 1940s both the Great Crested Grebe *Podiceps cristatus* and the Blacknecked Grebe *P.nigricollis* were considered "rare winter visitors" or vagrants. *P. cristatus* was first recorded nesting on the Khijadia Wetland near Jamnagar by Taej Mundkur and for the last decade there has been regular breeding there and assured sightings on several reservoirs of Saurashtra, Kachchh and central Gujarat. Freshwater jheels adjoining saline marshes appear to be favoured locales and *P. cristatus* may spread to suitable water bodies along the coast, provided these are not polluted by sewage and untreated industrial effluents. *P. nigricollis* has been recorded on several occasions on open, deeper reservoirs and appears to be less of a vagrant than was believed. The Rednecked Grebe *P. griseigena* has been unsatisfactorily identified and more regular birdwatching is needed to confidently place it, albeit as a rare winter visitor, on our checklist. The Little Grebe *P.ruficollis* continues to be a common resident species with numbers augmented in winter by northern migrants. It disperses during the southwest monsoon to nest in rainfed depressions. Threat is mainly from pesticide and inorganic chemical manure concentrations in the water affecting aquatic insects and fish on which the young are fed. During the non-breeding season, the birds concentrate on the perennial waterbodies where they get entangled in fish nets.

Family PROCELLARIIDAE: Petrels and Shearwaters

These are all birds of the open ocean. Occurrence in our area is accidental. We can contribute little towards their conservation.

Family HYDROBATIDAE: Storm Petrels

Pelagic, undoubtedly occuring on high seas. Little information from seafarers. No conservation action recommendable.

Family PHAETHONTIDAE: Tropic Birds

Tropical Oceanic Birds. Occasional in our seas. No quantitative information. No conservation action recommendations.

Family PELECANIDAE: Pelicans

Three species mainly winter visitors. Great fliers optimally using water bodies. The Rosy Pelican *Pelecanus roseus* successfully nested with flamingoes in the Great Rann. Sálim Ali discovered the nesting in 1960. They may regularly nest with the flamingoes. Pelicans need plenty of fish and the main conservation need is to ensure water quality of freshwater jheels. The Dalmatian Pelican *P. crispus* is a threatened species worldwide, while the Spottedbilled Pelican *P. philippenis* nests in South India in declining numbers.

Family SULIDAE: Boobies

Three species of these oceanic island-nesting birds occur out at sea. Sightings are unreported except for occasional storm driven birds on our shores. Information needs to be collated. No conservation action indicated within our area.

Family Phalacrocoracidae: Cormorants and Darter

Gujarat has a major role to play in the continued success of this family. Formerly there were thriving nesting colonies of the Large Cormorant *Phalacrocorax carbo*, the Little Cormorant *P. niger* and the Darter *Anhinga melanogaster* across Kachchh, Saurashtra and mainland Gujarat. Most of these colonial nesting sites are lost on account of felling of trees. The pollution and drying up of river pools has reduced fish populations, hence these birds. In fact the Darter can no longer be considered "Common" in freshwater locales, though a significant population remains centred on the mangrove swamps of the Gulf of Kachchh. Significantly, the Darter is considered a freshwater species — the Gulf of Kachchh population is marine and the Marine National Park off Jamnagar and extending to Beyt Dwarka is an important area for conservation of this species which, because of pollution of freshwater habitats, is endangered. Trees in flooded areas are important for cormorants to nest on. The Indian Shag *P. fuscicollis* still remains an enigma and Sálim Ali's 1954 comment "Noted: Kanewal (Cambay). Possibly overlooked elsewhere" holds true. I believe the immense flocks periodically observed near Jamnagar and flying up some of the Saurashtra rivers could be of this species. Nesting colonies have to be yet confirmed. Fishing nets in Kanewal and other freshwater jheels are a threat to these diving fish predators.

Family Fregatidae: Frigate Birds

Birds of oceanic islands. Not yet reported from our area. Two species in Indian Ocean.

Family Ardeidae: Herons, Egrets and Bitterns

Gujarat is an important area for this family. In the Gulf of Kachchh there are mixed nesting colonies of Grey Heron *Ardea cinerea*, Large Egret *A. alba*, Smaller Egret *Egretta intermedia*, Indian Reef Heron *E. gularis* and Night Heron *Nycticorax nycticorax* on remnant mangrove jungles in the Marine National Park off Jamnagar; breeding commences early in April and continues into May and June. On the Bhavnagar coast and in locations in the city nesting continues during the southwest monsoon. August and September are important in flooded areas of Ahmedabad and Kheda Districts. Most of the inland colonies of Kachchh and Saurashtra are lost. The Little Egret *E. garzetta* which nested during the rains over the region is now compelled to nest with *E. gularis* and interbreeding has been reported. The Purple Heron *Ardea purpurea* is less common than earlier in the century on account of loss of the favoured reedbeds. The Cattle Egret *Bubulcus ibis* and the Pond Heron *Ardeola grayii* are holding out well and nesting colonies are established in every available grove of tall trees during the height of the southwest monsoon. The mangrove nesting site at Kandla referred to by Sálim Ali no longer exists. If birds are still nesting at Kandla they would have transferred to new trees inland as they have in the precincts of Bhavnagar port. Night Herons *N. nycticorax* are to be found all over the region in full crowned old trees, seen within urban locales. Sálim Ali writes about the Little Green Heron *Ardeola striatus* "Solos in bushes bordering streams and tidal mangroves... Doubtless resident, but no data on breeding within area". We have not yet bettered this information. Water pollution and destruction of waterside vegetation undoubtedly must have had adverse effects on this little heron's range.

In his surveys Sálim Ali came across none of the bitterns. Both the Yellow Bittern *Ixobrychus sinensis* and the Chestnut Bittern *I. cinnamomeus* have been recorded flying over reedbeds by many birdwatchers. Parasarya has confirmed nesting records of these two bitterns along with that of the Black Bittern *I. flavicollis* while Lalsinh Raol has a recent sighting of the Bittern *Botaurus stellaris* in North Gujarat, a species referred to by Sálim ali on the basis of old shikar records. Birdwatchers should keep a vigilance for the Little Bittern *I. minimus* and the Tiger Bittern *Gorsachius melanolophus,* both species most likely to turn up in winter if not nesting with us. Water pollution and filling in of wetlands pose a threat to their existence.

Family Ciconiidae: Storks

Sálim Ali's comments for all our resident storks remain valid today, except that nest site crowding on account of loss of larger trees particularly in older traditional sites is considerable. There is an unusual nesting colony of the Painted Stork *Mycteria leucocephala* on a sandstone island in the Gulf of Kachchh. Openbill Storks *Anastomus oscitans* nest on smaller inundated trees in the flood plains of central Gujarat. Whitenecked Storks *Ciconia episcopus* has become more frequent in Saurashtra and also Kachchh but whether this is dispersal on account of increase in population or influx of birds from outside the State in search of favourable nesting trees is a moot point. The Blacknecked Stork *Ephippiorhynchus asiaticus,* if anything, has become sparser and the greatly separated pairs seem not to be successful in breeding, the species needs to be carefully watched.

The status of both the White Stork *Ciconia ciconia* and the Black Stork *C. nigra* has undergone a dramatic change. Both are winter visitors, *C. ciconia* has been seen in flocks of above 200 among fields and in roadside ditches south of the Nal Sarovar. Birds are, however, very mobile and concentrate or disperse depending on food availability. *C. nigra* has become more regular in the Gir and other parts of the State; there has been an increase, but whether this is on account of a population increase or because of dispersal for suitable remaining habitats is questionable. Both species of Adjutant Storks *Leptoptilos dubius* and *L. javanicus* are on the Gujarat list because of old sight records in Kachchh and north Gujarat.

Our resident storks are pressed for nesting sites and existing trees need to be identified and protected even as suitable planting of former known locations is commenced as a special programme.

Family Phoenicopteridae: Flamingoes

Both the Flamingo *Phoenicopterus roseus* and the Lesser Flamingo *Phoeniconaias minor* are plentiful. Gujarat is the breeding and dispersal centre for the flamingoes of the subcontinent. The former is more widespread in freshwater jheels, estuarine mud and on flooded Ranns and saltpans. The latter is concentrated along the sea coasts and the Ranns. The expanding salt industry has provided favoured habitats for both flamingoes and at times they assemble in thousands on larger pans. At the Great and Little Ranns, both species assemble to nest in immense flocks. Considering the huge numbers of *P. minor* with juveniles, it is puzzling why no large nesting colony has been recorded. This is largely, I aver, on account of a casual approach by us birdwatchers. This, however, is to advantage since publicity has resulted in groups of visitors to Flamingo City once making the birds desert a highly successful nesting endeavour — such disturbances for a disaster prone lifestyle as of flamingoes can prove seriously damaging to the species' very survival. Flamingoes of both species appear to find rich feeding in sewage discharges as well as in effluent ponds of chemical industries. Long term effects on the birds' vitality, however, need to be examined. It must also be borne in mind that the Ranns are highly unstable ecosystems and that of late the huge quantities of salt encrustation are being eyed by industry. Effective management strategies need to be evolved to the benefit of the birds and for industrial needs before serious confrontation develops. That flamingoes are a tenacious group of birds apparently highly adaptable to human proximity is demonstrated by a magnificent flock of several thousand *P. minor* regularly visiting a sewage drainage area within Porbandar city where I was shown several pairs attempting to nest in full view from a busy road.

Family Threskiornithidae: Ibises, Spoonbill

Both the White Ibis *Threskiornis aethiopica* and the Black Ibis *Pseudibis papillosa* are holding out well, the former regularly nesting on inundated trees at all existing communal nesting sites and on islands in the Gulf of Kachchh, the latter has adapted well to nesting on tall trees in cities. In the Gulf *T. aethiopica* starts nesting in March as do the marine herons, egrets and darters. On inland locations breeding occurs during August and September. The Spoonbill *Platalea leucorodia*, though widespread, has perceptibly declined and no longer can be considered "common". The decline is attributable to decimation of the former inland nesting sites in Saurashtra and Kachchh.

The Glossy Ibis *Plegadis falcinellus* continues to be an enigma. This is a very visible bird on inundated areas of central Gujarat and a large roost exists on the outskirts of Vadodara, yet there were no nesting records till a colony was located among water logged *Prosopis juliflora* plantation in Kachchh by J.K. Tiwari on a BNHS field programme. If local birdwatchers were as active during the rains as they tend to be in the cool season, colonies would assuredly be located.

Family Anatidae: Ducks, Geese, Swans

This group of wildfowl were best observed and information collated of on account of the many "Sporting" events formerly organised by the aristocracy. A good many jheels were well covered, the most well known being the Nal Sarovar, striking distance to its east from Ahmedabad and from its west from Limbdi whose princely family organised annual "shoots" for fellow princes and British dignitaries. Kachchh too was intensely covered. Today our information on waterfowl is far more sketchy, though the annual waterbird counts are replacing the shoots as "events". Most of what was recorded by Sálim Ali remains true, with a few very significant changes. The Greylag Goose *Anser anser*, recorded as "rare in northern Gujarat", is fairly plentiful around Ahmedabad and morning flights from irrigated croplands to roost beside the large, newly constructed reservoirs on the major rivers are stirring sights. The Barheaded Goose *A. indicus* has started regularly wintering on a couple of Saurashtra tanks. It was in one such flock that the intrepid Taej Mundkur spotted a Snow Goose *Chen hyperborea* subsequently confirmed by the late Shivrajkumar Khachar. As greater numbers of amateur birdwatchers go on "wildgoose chases" more interesting information on geese and other waterfowl is to be expected. Great care, however, needs to be exercised in identification, particularly in the case of the rarer geese and swans, since we do not want veracities doubted as was Stolizcka's claim of sighting swans in the Great Rann in 1870. Off colour flamingoes in belly deep water look remarkably like swans to an eager enthusiast!

Comments for our wintering ducks remain the same, though the large concentrations of the forties seem to have evaporated. Both the "dabbling" duck and the "diving" duck are found in smaller numbers today. If the high concentration of coot on the Nal and other jheels is any indication, vegetational changes in the traditional waterbodies appear to be the reason. Netting for fish now legal on most waterbodies, may also be a significant contributory factor for the decline in water fowl.

The Ruddy Shelduck *Tadorna ferruginea* is certainly not "a rare and erratic" winter visitor. The larger reservoirs all over the State have their complements of this "wide awake" though not necessarily "excessively wary" bird. The Common Shelduck *Tadorna tadorna* continues to be "a very rare winter visitor".

Among our resident ducks, the Spotbilled Duck *Anas poecilorhyncha* has most certainly increased in numbers, having successfully used the great many percolation farm ponds to its advantage to nest in. The Lesser Whistling Teal *Dendrocygna javanica* seems to be less successful and needs to have a watch kept on its annual nesting successes. This is true of the Comb Duck *Sarkidiornis melanotos* as well as the Cotton Teal *Nettapus coromandelianus*. I am not too sure whether their spread into Saurashtra is on account of population increase or resulting from disturbances at their former Gujarat nesting village ponds. Loss of large trees with nesting hollows should be a matter for concern. Felling of trees, deterioration in water quality and fishing are accelerating threats to the group, particularly our tree nesting ducks. A greater number of reservoirs and extension of irrigation will be of advantage, especially to the winter migrants.

Family Accipitridae: Raptors, Vultures

This magnificent group of birds has shown a dramatic decline. Where once a single morning's outing would yield scores of hawks and eagles, today a 100 km drive produces hardly a bird or two! The fading away of raptors from our avian fauna highlights most graphically the immense degradation that has taken place in our environment. Perhaps a very detailed report needs to be prepared. The reasons for the decline are manifold — pesticide poisoning, habitat loss and prey availability reduction are all contributory. In the case of migrant raptors, problems are international, but for our resident species, one of the most significant problems is the loss of large nesting trees. This is most graphically demonstrated by the Whitebacked Vultures almost compulsively moving into public parks within cities. The more shy eagles are being driven to extinction largely on account of nesting failures. The Tawny Eagle *Aquila rapax*, once a common bird, is now rare. Other breeding eagles like the Short-toed Eagle *Circaetus gallicus* and the Bonelli's Eagle *Hieraaetus fasciatus* have become scarce. Sálim Ali's reassuring "fairly common" no longer obtains for the former, while the latter perhaps still operates from traditional nesting sites on old forts or hill crags, most tree eyries are lost.

Booted Eagles *Hieraaetus pennatus* are comparatively common in winter, though there has been no subsequent record of the species nesting in our area since Sálim Ali's record at Deesa. The Blackwinged Kite *Elanus caeruleus* is perhaps our commonest raptor in cultivated and lightly wooded country. Goshawks, Shikra, and Sparrow Hawks need more attention, though the resident *Accipiter badius* is holding out fairly successfully.

Pariah Kites *Milvus migrans* have certainly lost ground. There was a very noticeable crash in numbers in the 1950s after concerted drives to poison rodents whose predation is again vigorous as before, though kite losses have still not been made up! Apart from a bird seen by Shivrajkumar, there are no recent records of the Red Kite *M. milvus* and Sálim Ali's conjecture that the bird is "a regular winter visitor to Kutch but has been overlooked ..." may well apply to Saurashtra and northern Gujarat.

The buzzards of the genus *Buteo* are all winter visitors, not easy to identify and their numbers have very considerably declined as have those of the once exceptionally plentiful White-eyed Buzzard-Eagle *Butastur teesa*, which in the forties had been our "Commonest hawk of the area". To see one calls for some excitement! Fortunately, the Honey Buzzard *Pernis ptilorhychus* continues to be regularly sighted perhaps because its food - the Rock Bee — is still very plentiful in mainland Gujarat. Elsewhere it is more often seen during the cool season when northern birds arrive. The Crested Hawk Eagle *Spizaetus cirrhatus* continues to be "not uncommon in forested country" as indeed the Crested Serpent Eagle *Spilornis cheela* is in the Gir and the Dangs. Though there has been considerable forest degradation, little pesticide use has been resorted to by the "backward" tribal farmers, and as such Sálim Ali's notations of half a century ago can still be applied to the Serpent Eagle.

The Pallas's Fishing Eagle *Haliaeetus leucoryphus* and the Greyheaded Fishing Eagle *Ichthyophaga ichthyaetus* have become great rarities now that the larger rivers are dammed and riverpools overfished and dynamited. In Saurashtra, both species used to predate heavily on inland mixed nesting colonies of cormorants, egrets and spoonbill.

The migrant Steppe Eagle *Aquila nipalensis*, the Imperial Eagle *A. heliaca*, the Greater Spotted Eagle *A. clanga* and the Lesser Spotted Eagle *A. pomarina* have all become scarce and all sightings need to be recorded. Sálim Ali has "Definitely observed only once - a single..." Black Eagle *Ictinaetus malayensis* at Jambughoda an area considerably north of the Narmada valley. I am not aware of any subsequent sightings. This magnificent raptor is a bird of the forested Western Ghats systems and despite considerable degradation of the hill forests, birdwatchers should be advised to keep a look out for a long winged black eagle coursing along the escarpments specially over hills of Rajpipla and the Surat Dangs further south. Another magnificent eagle still fairly common along the western seacoast south of Bombay is the Whitebellied Sea Eagle *Haliaetus leucogaster.* There seems no reason for this fine bird from occurring further north along the seaboard and it should not be surprising if pairs are found nesting on tall trees along coastal plantations in Navsari District. Nonbreeding individuals may well turn up over the estuaries of the Mahe and the Sabarmati at the head of the Gulf of Khambhat. Infact, though Sálim Ali had not come across this eagle during his surveys, he lends credance incorporating a sight record by Harinarayan Acharya at Gobhlaj jheel "18 miles south of Ahmedabad on 9.2.1936...." This is a freshwater jheel at some distance from the seacoast, but the deep intrusions by tidewater up the estuaries certainly makes is quite possible for a superb flier to drop in on water well stocked by fish and aquatic birds.

This brings us to the vultures. The Black Vulture *Sarcogyps calvus*, never numerically plentiful, is now restricted to the Gir and Kachchh largely on account of nesting tree loss, I believe. The still common Whitebacked Vulture *Gyps bengalensis*, less shy has converged for nesting on large trees in urban parks not, as some believe, on account of population increase, but because of felling of large trees in rural areas. There are reports of this vulture nesting on house tops in western Kachchh! The Longbilled Vulture *G. indicus*, always limited by its nesting on crags, continues to be as common as before. If there has been a marginal decline, I would suspect it is on account of pesticide poisoning. This is most certainly the main reason for the Scavenger Vulture *Neophron percnopterus* dropping from Sálim Ali's "Fairly common over the whole area", to what I would call uncommon. Both the Cinereous Vulture *Aegypius monachus* and the Griffon *Gyps fulvus* are winter visitors in small numbers. The latter certainly is not "a rare straggler" as recorded by Sálim Ali. This, however, is true of the Himalayan Griffon *G. himalayensis* which strays down in winter, as proved by an exhausted bird captured at Hingolgadh and housed for years in the Ahmedabad Zoo.

Of late, harriers have highlighted Gujarat most favourably on account of immense congregations assembling to roost in the Velavadar National Park. This assembly is entirely because of the prime harrier habitat remaining (by active manipulation) in the Park. Elsewhere, sighting a couple of these harriers causes excitement, whereas a few decades ago all three — the Pale Harrier *Circus macrourus*, Montagu's Harrier *C. pygargus* and the Hen Harrier *C. cyaneus* were the joy of birdwatching on windy, winter mornings. Strangely, Sálim Ali makes no mention of *C. cyaneus*. The decline of the three Harriers can be attributed to the loss of grasslands, infestation of pastures by *Prosopis chilensis* and the shift of "Kharif" cultivation from cotton, millets, etc., to monoculture of groundnut and of course the attendant spraying of pesticides. On the other hand, the distinctively sexually dimorphic Marsh Harrier *C. aeruginosus* continues to be a "Winter visitor, fairly common, singly, at jheels and marshes".

The Osprey *Pandion haliaetus* is a "Winter visitor, not abundant but usually one or two present on most of the larger rivers and jheels" and I may add all along the sea coast as well as on the large reservoirs constructed after 1947.

Family Falconidae: Falcons

Falcons were greatly valued in princely times as they are today by the rich Arab Sheikhs. Knowledge of falcons: their identification, capture and training to fly off the fist after hare, partridge and bustard, was honed to a fine skill. Unhappily today, the art of falconry is dead and information on this great group of birds is as meagre as it was voluminous and qualitative half a century ago. Like the other birds of prey, falcons have considerably declined in number on account of habitat degradation, pesticide poisoning and above all, in the case of the resident Laggar Falcon *Falco biarmicus* and the Redheaded Merlin *F. chicquera* because of felling of tall trees holding traditional nests. Those laggars nesting on fort balconies and hill crags are continuing to successfully raise young, as indeed does the Shaheen *F. peregrinus peregrinator* on the crags of Girnar in Saurashtra, and Mt. Abu just north of Gujarat. Sálim Ali does not mention the Shahin and his "Fairly common" for *F. biarmicus* and *F. chicquera* no longer operates and our responsibility towards conservation programmes for them is great because they breed here. Preservation of existing nests, and putting up artificial nests are among the significant steps to take.

The migratory race of the Peregrine Falcon *F. p. japonensis* continues to be a "winter visitor. Not common and occasional." Its fate depends more on situations in its temperate breeding range. Fairly frequent and excellent sighting can be had around the seacoast and on the edges of the Ranns where prey is plentiful in the vast hordes of shorebirds. This is also true for the Hobby *F. subbuteo*. Unhappily, the "common winter visitor" the Kestrel *F. tinnunculus* is considerably less so no doubt on account of altered habitats of grass and open savannah and pesticides. In recent years, the Lesser Kestrel *F. naumanni* and the Redlegged Falcon *F. vespertinus* have been recorded in Saurashtra, the former outside Rajkot and the latter twice on the western seacoast. The status of wintering desert falcons is very unclear, thanks to our general incapability of identifying them.

Family Phasianidae: Pheasants, Partridges, Quails

This traditionally hunted and snared family of birds has shown an appreciable decline in numbers, not only on account of illegal snaring but because of habitat destruction and pesticide use in agriculture. The position of the Black Partridge *Francolinus francolinus* in Kachchh undoubtedly is the same as that of the Painted Partridge *F. pictus* elsewhere. The invasion by *Prosopis chilensis* on sand dunes, pastures and into grass preserves cannot but have a deleterious effect on the local fauna. The Painted Partridge is holding out well in the broken hill country of eastern Gujarat, which cannot be said for it in Saurashtra. The widespread Grey Partridge *F. pondicerianus* continues to be "a common" but certainly not "abundant gamebird over the entire area", while the Blackbreasted Quail *Coturnix coromandelica* continues to be heard in short monsoon vegetation.In Kathiawar in particular, numbers have declined as indicated if only by the otherwise continual calling during rainy days being less heard. The former "common winter visitor", the Common Quail *C. coturnix* is no longer plentiful, its decline possibly reflects habitat change in its northern breeding range. Both the Rock Bush Quail *Perdicula argoondah* and the Jungle Bush Quail *P. asiatica* are holding out in appropriate terrain, though large coveys are less "tread on" than before.

The position of both the Red Spurfowl *Galloperdix spadicea* and the Grey Jungle Fowl *Gallus sonneratii* cannot be said to be "common" or "uncommon" respectively and population decline is attributable to both direct snaring and indirect habitat degradation. The common Peafowl *Pavo cristatus* continues to be still visible and by and large unmolested, but its former highly favoured urban habitats of large, overgrown compounds have considerably dwindled, with the break up of properties and construction of high-rise buildings, though in Rajkot, peahens have taken to egg laying in balconies and on roofs! In the countryside too, the droves formerly seen are missing, undoubtedly on account of intensive farming practices and the application of pesticides. The loss of tall, sturdy boughed trees to roost in must also be a contributing factor. In the Gir forest, Pranav Trivedi has recorded them roosting high on electricity pylons.

Family Turnicidae: Bustard-quails

These tiny and highly inconspicuous little birds need more direct evidence to affirm their present status, though the loud, droning call of the Common Bustard-Quail *Turnix suscitator* is less heard than in the past. Over large tracts of cultivated land, intensive agriculture with the compulsive eradication of "weeds", obliterating of grassy verges and copious application of pesticides have made conditions inhospitable for all birds, including these tiny cousins of the stately Sarus. Marginal lands along riverbeds, with rocky outcrops, provide retreats where they survive under siege conditions.

Family GRUIDAE: Cranes

Gujarat continues to be a major crane region of the world and the fact that such huge numbers should continue to be audible and visible in a densely populated and highly agrarian landscape speaks volumes for the traditional values among the general population, and the great adaptability of these magnificent birds. Wintering flocks of Demoiselle Crane *Anthropoides virgo* continue to be evocative of clear winter mornings over Saurashtra's windswept landscape. Salim Ali had, and rightly so, continually emphasised the importance of the escarpments overlooking the Great Rann as vantage points to observe "migration, and the numerous species observed there...in the first week of October, perhaps the most spectacular were the flock upon flock of Demoiselle and Common Crane". The latter is more partial to the edges of the Ranns and estuaries where it feeds on tubers of a xerophytic sedge. The people of Gujarat should be proud of the fact that the State's agricultural heartland continues to be the most important habitat of the Sarus Crane *Grus antigone* in the Subcontinent. Intensive cultivation of rice on former Sarus marshes, garbage disposal in others near urban centres and the draining in of chemical effluents, sewage, pesticides and inorganic fertilizers into all depressions have disrupted the wetland ecology, making successful breeding by these large and spectacular birds difficult. Unless some very imaginative and popular programme is conceived, we may well witness a sharp decline in the population of the Sarus along with other resident waterbirds.

Family RALLIDAE: Rails and Coots

These excessively secretive birds have never really been well observed. Especially for the species of the genera *Rallus* and *Porzana*, all information on status is rather casual and observations incidental; whether there are resident and/or migratory populations appears to be largely speculative. The Ruddy Crake *Porzana fusca* was first recorded by me during the cool season and I am not sure how many further records exist. It was I who showed the late Dharmakumarsinhji the Brown Crake *Amaurornis akool* near Bhavnagar, and later showed that it commonly breeds in Kathiawar, Saurashtra. Salim Ali cites early observations by Butler which correspond to my observations — *A. akool* was common and widely distributed. The same is true of the Whitebreasted Waterhen *A. phoenicurus* which, however, is less secretive and singularly noisy during the rains when it nests. Salim Ali recorded it as "not common", though I would say it was, as it still is, locally common in the past, being absent from some of the better known "shikar jheels". Very little was known of the large Kora *Gallicrex cinerea* till suddenly in the 1960s they started turning up in quite unexpected places like irrigated farmlands — the quite phenomenal disappearance of reedbeds and desiccation of perennial river pools literally flushed out this otherwise extremely secretive bird. The position today remains an enigma. The Moorhen *Gallinula chloropus* was "fairly common" but today its numbers have gone down and sightings are less frequent. The large and showy Purple Moorhen *Porphyrio porphyria*, in my opinion, had concentrations on larger wetlands in Gujarat from where they spread out to nest in the monsoon; thus the great fluctuations — it certainly is no longer common in Saurashtra. The Coot *Fulica atra* has a strong inflow of wintering birds but a few pairs have nested, curiously enough quite patchily. Large concentrations of Coot appear to indicate an ecological shift from clear water preferred by diving ducks to more weed choked water, attractive to moorhens and the like. Today, the destruction of reedbeds, overgrazing and wallowing by buffaloes, pollution by sewage, industrial discharges and landfills have severely disturbed the habitat of this group of marsh birds. We may well lose several species without knowing of the loss.

Family OTIDAE: Bustards

The disappearance of the Great Indian Bustard *Choriotis nigriceps* and the precarious current status of the Lesser Florican *Sypheotides indica* are a shame on grassland management by the State administration, which annually incurs huge expenses on purchasing hay from neighbouring States to feed its starving cattle. Kathiawar (Saurashtra), Kachchh and the hilly tracts of Gujarat can all produce immense quantities of hay for a highly profitable livestock industry. On this subject, the less said the better! Even well known nesting sites of the Great Indian Bustard — a couple of them declared Bustard Sanctuaries are overrun by livestock and planted over with *Prosopis chilensis*. Both the people and the birds have lost out! The Houbara *Chlamydotis undulata* is not "rare". It is, rather, a regular winter visitor to the semidesert margins of the Ranns and on the sand dunes of Saurashtra and Kachchh coasts. Disturbance by livestock and infestation by *Prosopis chilensis* on the saline grasslands and sand dunes would appear to be negative factors.

Family JACANIDAE: Jacanas
Family HAEMATOPIDAE: Oystercatcher
Family ROSTRATULIDAE: Painted Snipe

The Pheasant-tailed Jacana *Hydrophasianus chirurgus* is still common and widespread during monsoon in weed filled depressions. The drying out of Saurashtra and Kachchh waterbodies and pollution in Gujarat must be seen as threats to this as well as the "decidedly uncommon" Bronzewinged Jacana *Metopidius indicus.* The resident Painted Snipe *Rostratula benghalensis* is perhaps commoner than believed; its highly cryptic colouring and capacity to remain "hidden" beside the smallest of wet areas undoubtedly makes it easy to overlook. Besides, the breeding season is during the monsoon when few keen amateur birdwatchers are out in the field, so calling females are not heard. The boldly pied Oystercatcher *Haematopus ostralegus* is still fairly common during winter on the Kachchh and Saurashtra coastline. Numbers are greater on the oyster-encrusted rocky headlands from Okha to Pirotan Island north of Jamnagar.

Family RECURVIROSTRIDAE: Stilts, Avocets
Family DROMADIDAE: Crab Plovers
Family BURHINIDAE: Stone Curlews

I consider the Blackwinged Stilt *Himantopus himantopus* an indicator of the quality of water. This "one of the commonest waders on inland waters: present in varying numbers at every swamp, jheel, puddle or tidal mudflat" is still common. I believe stilts on tidal mudflats are quite incidental, since much of the diet there has to be vigorously probed for, for which the fine bills of stilts are not ideal. On the saltpans and the flooded Ranns, however, there often appear huge concentrations of free swimming copepods which, like mosquito larvae are ideal for stilts to pick off. As water gets polluted fish disappear, though mosquitoes breed in immense quantities with impunity and the teeming larvae attract large flocks of stilts. Further pollution, especially by chemical discharges, suppresses larvae and aquatic fauna, and stilts disappear. Their numbers have most certainly increased over the region. On the other hand, the Avocet *Recurvirostra avosetta* is enigmatic. A winter visitor, it appears at times in appreciable numbers, both on freshwater and on the saltpans — concentrations on the latter at times are a bird spectacle worthy of specially travelling to see! Salim Ali had "discovered a large breeding colony in the Great Rann of Kutch, off Nir on Pachham Island" in April 1944. There may well have been other such nestings in subsequent years. Avocets, like the stilt, appear to benefit by moderate water pollution and their large assemblages must consume huge quantities of mosquito larvae.

All information of the distinctive Crab Plover *Dromas ardeola* till my visit to Pirotan Island in December 1970 was faulty. Sálim Ali's "apparently a very rare vagrant" and Dharmakumarsinhji's disbelief at my identifying a distant flock of what he dismissed as terns, typify the knowledge till then. The Pictorial Guide has this to say "Largely crepuscular, maritime waders". Crab Plovers are not crepuscular, they operate at the very edge of the tide and their feeding and resting are dictated by the rhythms of the tide. So wedded are they to the water's edge that even in flight, while they readily fly across open water, flying low over it, they skirt headlands and sandbars, never crossing them! At high tide, all birds of a particular stretch of shoreline or exposed reef, collect to rest on a sandspit in flocks from forty to four hundred birds. On the tide turning, they scatter about, when an observer may see singletons at a distance. The enigma remaining is — where do the Gulf of Kachchh flocks nest? They are breeding very successfully, judging from the proportion of juveniles in each flock. Taej Mundkur suspects nesting off Jakhau in Kachchh. The Gulf of Kachchh is perhaps the best place to see this large, distinctive and ridiculously confiding wader.

The Burhinidae has two species, the Stone Curlew *Burhinus oedicnemus* and the large Great Stone Plover *Esacus magnirostris*. The former is "common" across the State, quietly resting in the shade of shrubs and trees in scrubland, unkept orchards and edges of cultivation. The bird's presence is made known by the distinctive call uttered "at evening dusk and before sunrise, and also on moonlit nights". The urban sprawl, resulting in the breakup of suburban properties with their rambling gardens has evicted this largely invisible yet audible bird from its most favoured habitats. The Great Stone Plover is a bird of rocky seacoasts, rocky outcrops around large reservoirs and the rocky beds of large rivers. They are certainly commoner than before, thanks to the many large dams constructed after the formation of the Gujarat State.

Family Glareolidae : Coursers, Pratincoles

Our knowledge of the two species of coursers, the Creamcoloured Courser *Cursorius cursor* and the Indian Courser *C. coromandelicus* has not increased beyond what was known half a century ago! The former is presumably a regular winter visitor to the desert-like edges of the Ranns, while the latter is largely overlooked in open cultivation, pastures and the undulating rocky plateau country of Saurashtra; information on their breeding is needed. Surprisingly, Salim Ali makes no mention of Pratincoles; both the Large or Collared Pratincole *Glareola pratincola* and the Small Indian Pratincole *Glareola lactea* are frequent over the many old and new reservoirs of the area. They nest sporadically beside the Saurashtra and Kachchh reservoirs. Their status has most assuredly improved!

Family Charadriidae: Plovers, Sandpipers, Snipe

The extensive tidal mudflats, inundated Ranns, associated saltpans and the network of rainfilled jheels and flooded depressions, all form a rich mix of habitats favoured by this family of birds known collectively as waders. Their numbers have shown no decline. The Broadbilled Sandpiper *Limicola falcinellus* which Salim Ali mentions while commenting on flocks of small waders in the following vein: "These flocks, doubtlessly contain examples of the Broadbilled Sandpiper" are confirmed as regular visitors especially on either side of the Gulf of Kachchh, where recent reports of the Eastern Knot *Calidris tenuirostris* suggest that the species is a regular winter visitor. There have been no recent sightings of the Sociable Lapwing *Vanellus gregarius* which is enumerated by Salim Ali on the strength of Butler's 1876 report of the species being "very common during the cold weather in the neighbourhood of Deesa". More extensive birdwatching has revealed the rather frequent occurrence of Rednecked Phalaropes *Phalaropus lobatus* on saltpans and brackish lagoons on the Saurashtra seaboard. Observations have revealed that the Bartailed Godwit *Limosa lapponica* has a preference for sea coasts, while the Blacktailed Godwit *L. limosa* prefers backish, inland water and freshwater jheels. In their preferred habitats both species are equally plentiful. The Temminck's Stint *Calidris temminckii* of which Salim Ali states "Usually in mixed flocks..." is more a bird of fresh rather than saline waters which are equally favoured by the undoubtedly more plentiful Little Stint *C. minutus*. Apart from these observations, the status of all other waders remains unchanged. Some intensive scientific examination, however, needs to be undertaken to assess the effect of huge quantities of sewage and industrial wastes being emptied via the rivers into the Gulf of Khambat. Any increase in toxins into the tidal mud may well affect a sizable segment of the population of Palaearctic waders.

Family Stercorariidae: Skuas
Family Laridae: Gulls, Terns

Skuas are gull-like predators of Polar seas and in Salim Ali's language "Within our limits, the records are mainly of accidental waifs storm-tossed during heavy monsoon gales." He does not mention them in his Gujarat reports. Being a maritime state but lacking seagoing birdwatchers, Gujarat may well have Skuas turning up more frequently. We have our fair share of gulls and terns, however. The Blackheaded Gull *Larus ridibundus* and to a lesser extent the Brownheaded Gull *L. brunnicephalus* are plentiful at all ports and present in smaller numbers on inland reservoirs especially in Kachchh and Kathiawar, and in concentrations over the inundated Ranns. Both the Lesser Blackbacked Gull *L. fuscus* and the Herring Gull *L. argentatus* are met in small numbers on inland reservoirs and along the coast, with a particularly impressive gathering each winter at Okha, where the latter are predominating. Sálim Ali makes no mention of the Great Blackheaded Gull *L. ichthyaetus* which is regular in solos and small parties on larger reservoirs of Kachchh and Saurashtra; it is also a regular feature along the sea coast and especially so on the reefs of the Marine National Park between Okha and Jamnagar. The Little Gull *L. minutus* was seen by Sálim Ali himself in flocks over the flooded Great Rann during one of his later visits there; Taej Mundkur has seen them though I have no other reports. Dharmakumarsinhji spoke of the Slenderbilled Gull *L. genei* as a rare winter visitor in a vague sort of manner and it was Lalsinh Raol, whom Sálim Ali rated very highly, who definitely confirmed that the bird was a not uncommon wintering species off the Jamnagar coast, I have regularly seen them off Beyt Dwarka. Our knowledge of terns, especially the migratory, and more marine ones is comparatively meagre and more information is needed. Taej Mundkur reported nesting of the Little Tern *Sterna albifrons* in saltpans on the Jamnagar coast, while a regular colony breeds at Bhavnagar, where the birds had been filmed by Dharmakumarsinhji. The Large Crested Tern *S. bergii* and the Sandwich Tern *S. sandvicensis* and the lesser crested tern *S. bengalensis* are commoner than believed. More intensive birdwatching may confirm that Gujarat is on the itinerary of the migratory Common Tern *S. hirundo*, the Roseate Tern *S. dougalli* and the Black Tern *Chlidonias niger.* Sálim Ali did not come across the regular, though uncommon wintering Whitewinged Black Tern *C. leucopterus.* Both *C. niger* and *C. leucopterus* can be overlooked in winter plumage among the flocks of wintering Whiskered Terns *C. hybrida*, a plentiful species along the coasts and inland.

The large number of reservoirs have provided nesting islands for the Indian River Tern *S. aurantia*, but pollution and desiccation of rivers and inland marshes have made this formerly familiar species less so. Sálim Ali's notation " I can trace no record of its breeding in Gujarat..." surprises me, since I have been inducted into the joys and tribulation of bird photography at Jasdan in Saurashtra, sitting over nests of this and the Blackbellied Tern *S. melanogaster* of which Sálim Ali writes "Status uncertain". The large reservoirs constructed during the last few decades have most certainly become nesting areas for these terns in Gujarat — River Terns have been nesting regularly on the Aji and Niari reservoirs of Rajkot. The Little Tern *S. albifrons* is common on large inland reservoirs and along the coast, particularly so in sheltered water of the Gulf of Kachchh. *S. albifrons* has been filmed nesting near Bhavnagar by Shivbhadrasinh as had been done earlier by his naturalist uncle, Dharmakumarsinhji. Taej identified both *S. a. albifrons* and *S.a. saundersi* around Okha; they are now considered distinct species.

The Gullbilled Tern *Gelochelidon nilotica* is perhaps one of the most visible species over tidal flats and inland, even highly polluted water. Sálim

Ali's "it is not unlikely that they may breed in the neighbourhood" (Nir on the edge of the Great Rann) should encourage amateur birdwatchers to extend their outings beyond comfortable weekend jaunts. The Caspian Tern *Hydroprogne caspica* is an unmistakeable presence on the Kachchh and Saurashtra coasts as well as on larger inland reservoirs. There is all likelihood of this fine tern nesting in Kachchh and on the Jamnagar coast. Sálim Ali did not come across the Indian Skimmer *Rynchops albicollis* flocks of which, sometimes a hundred strong, sporadically put in an appearance on major waterbodies both fresh and brackish. Status remains uncertain.

Family Pteroclididae: Sandgrouse

I can, with confidence, state that our knowledge of this family has not been improved since the 1940s report by Sálim Ali. The Indian Sandgrouse *Pterocles exustus* continues to be widespread over the entire State, including as I found on the sand dune islands of the Gulf of Kachchh. The Painted Sandgrouse *P. indicus* is also holding out well in rocky hill country amidst degraded forests of all types. More effort needs to be put in to update the information on the wintering Imperial Sandgrouse *P. orientalis* and the Spotted Sandgrouse *P. senegallus*. There is all likelihood of the former being more regular and commoner than believed and even "very abundant" as recorded by Butler and the latter actually breeding along the edges of the Ranns which are their main habitat.

Family Columbidae: Pigeons, Doves

The Blue Rock Pigeon *Columba livia* continues to live up to Sálim Ali's observation "Common over the entire region, affecting buildings, whether derelict ruins or in occupation... A popular nesting site ... is down the vertical shafts of disused wells ..." To these favoured places I may add rocky islets out at sea, emphasising the virtuosity of this highly adaptable bird. High rise buildings are providing more vertical nesting space in urban conglomerations, as are the ubiquitous industrial sheds. Thus, this species continues to be a highly successful one. Surprisingly, the Yellowlegged Green Pigeon *Treron phoenicoptera* (which half a century back was known as the Southern Green Pigeon), is unobtrusively successful in all its strongholds of the Gir forest in Saurashtra and over mainland Gujarat; unhappily most of the fine old avenues of shade trees which provided it a ramification into other parts are gone thanks to old trees being felled by road widening and their replacement by "quickie" trees so dear to the professional forester.

Of the four resident doves, the Indian Ring Dove *Streptopelia decaocto*, the Red Turtle Dove *S. tranquebarica*, the Spotted Dove *S. chinensis* and the Little Brown Dove *S. senegalensis*, *S. tranquebarica* seems to have specially suffered immense losses along the new highways with their speeding traffic. This dove just has not learnt to recognise the danger of vehicles, and tends to take off too late to avoid collision with the speeding behemoths. In the countryside, as well as in lightly built-over area, all the other doves are doing well. *S. chinensis*, never an urban bird, continues to be plentiful all over its former "wellwooded areas". The winter migrant Rufous Turtle Dove *S. turtur* presumably continues to be "Excessively shy" and "Not uncommon in open glades and along cart tracks in bamboo and mixed deciduous forest" or what may be left of them in the Surat Dangs where too, the Emerald Dove *Chalcophaps indica* can still be heard. Its range has assuredly got constricted, judging from the efficient destruction of natural vegetation on the hills north of the Dangs and by no stretch of the imagination can this pretty dove be thought to occur at Songadh which "appears to be the most northerly record for this species on the western side of India". Birdwatchers may attempt to confirm the Emerald Dove's existence in "...Rajpipla and at least to the Narbada River" in what today is the much publicised Shoolpaneshwar Sanctuary.

Family Psittacidae: Parakeets

The three parakeets the Roseringed Parakeet *Psittacula krameri*, the Alexandrine Parakeet *P.*

eupatria and the Blossomheaded Parakeet *P. cyanocephala* are holding out. Sálim Ali's observations on the last species can be upgraded by adding the Gir forest to its range. The destruction of gnarled trees with their cavities for nesting and the practice of highly sterile moonocultural forestry plantations are a threat to this otherwise vigorous family. *P. eupatria* and *P. cyanocephala* have not taken to nesting in buildings, nor have they learnt to raid crops and are far less successful in adapting to "progress" than *P. krameri,* which in Sálim Ali's words occupies "Holes in walls of buildings ... even in the heart of noisy bazaars". There are immense roosts in large trees outside the Ahmedabad Junction and in the compound of the Circuit House in Vadodara. Unhappily, the new high rises are singularly free of potential nesting sites.

Family CUCULIDAE: Cuckoos

Of the eight cuckoo species recorded by Sálim Ali, the Pied Crested Cuckoo *Clamator jacobinus* continues to herald the welcome SW monsoon rains throughout Gujarat. The Koel *Eudynamys scolopacea* continues to be a shadow of the ubiquitous House Crow. The Sirkeer Cuckoo *Taccocua leschenaultii* and the Coucal *Centropus sinensis*, both nonparasitic cuckoos, are fairly common and appear to be doing especially well in dense shrubberies of eroded river banks and hedgerows. The Common Hawk-Cuckoo *Cuculus varius* is fairly common in mainland Gujarat and over the last couple of decades appears to have adapted to thorn-scrub in Hingolgadh where we had never ever heard it, even at the height of the monsoon. The Cuckoo *C. canorus* is one more of the avian enigmas of the region : Sálim Ali found cuckoos "searching for nests to lay in". This he observed in August in Kachchh when "larks and pipits were breeding." I always believed that Cuckoos were largely autumn passage migrants, with a few staying over in winter. The Cuckoo was heard calling in the Panch Mahals, along with the Pied crested cuckoo and the Hawk-Cuckoo on 21st July, 1996 - obviously not a passage migrant! Birdwatchers would be advised to place cuckoos as a group on their prime agenda, since we need to determine the status of the Indian Banded Bay Cuckoo *Cacomantis sonnerati*, which Sálim Ali records and comments on the resemblance of its call to that of the Indian Cuckoo *Cuculus micropterus* and the Indian Plaintive Cuckoo *Cacomantis passerinus,* both species which should be anticipated. The reconfirmation of the 31st October, 1945, sight record at Ajwa, Baroda of the Small Greenbilled Malkoha *Rhopodytes viridirostris* is another recommended assignment. The occurrence of the unusual looking Drongo-Cuckoo *Surniculus lugubris* is worth investigating in the heavy rainfall areas of south Gujarat.

Family STRIGIDAE: Owls

Owls, unfortunately, are so surrounded by superstition that very few people are remotely aware of their tremendous value as predators of nocturnal rodents, and large insects - mainly beetles whose grubs cause damage to plant roots in the soil. Their decline has caused hardly a ripple of concern among ornithologists. In fact, very little new information has been garnered since the classical period of collections. Their status at best can be a matter largely of conjecture. All our resident owls are hole nesters and over large stretches of Saurashtra and Kachchh, the loss of old trees and the absence of crags and deeply eroded river sides to provide alternate nesting and daytime roosting sites has greatly restricted the ranges of most owls. The Barn Owl *Tyto alba* continues to lead its phantom life in urban areas as well as in the countryside where there may be larger buildings of old landlord families. Unhappily, modern construction is owl-unfriendly, lacking rafters and false ceilings to provide shelters. The "common" Spotted Owlet *Athene brama,* because of its small size, continues to be widespread and appears to have benefited by streetlights which attract night-flying insects. The widespread spraying of pesticides most certainly has had adverse effects on this engaging wide-awake little owl. If special endeavour is justified to rediscover the chimaeral Forest Spotted Owlet *A. blewitti*, it should be justifiable to make a comprehensive study of the status of all the other species of owls like the Collared Scops Owl *Otus bakkamoena* which, as mistnetting operations established, was more widespread than suggested by Sálim Ali's reports; the Jungle Owlet *Glaucidium radiatum* "Common" in S. Gujarat, the Brown Hawk-Owl *Ninox scutulata* "Heard and seen" at several places in Surat Dangs, the Mottled Wood Owl *Strix ocellata* noted by Sálim Ali in mainland Gujarat and recorded by Dharmakumarsinhji as well as myself in Saurashtra. All these owls must have lost ground, thanks to the disappearance of old trees, the widespread plantations of Eucalyptus and *Prosopis chilensis*, two among the several "quick growing" aliens so favoured by the Forest Department and of course the terminal effects of pesticides. A winter visitor, the Shorteared Owl *Asio flammeus*, is perhaps more plentiful than previously thought, though its preferred habitat of grassland is considerably reduced.

Of the large resident owls, the Great Horned Owl *Bubo bubo* continues to be widespread particularly among ravines, around forts (Hingolgadh is a favoured base) and quarries out of commission. Few large enough trees survive to shelter this large owl. Confirmation of the status of the Dusky Horned Owl *B. coromandus* and the Brown Fish Owl *B. zeylonensis* calls for continual monitoring; the latter is still present in the Gir, though elsewhere, Sálim Ali's "not uncommon in wooded country in the neighbourhood of tanks and rivers" for the latter and "A very diurnal owl, often on the move and hunting during daytime" for the former, in what is the most intensively cultivated part of the State, needs to be confirmed.

Family CAPRIMULGIDAE : Nightjars

Nightjars are birds best identified by their calls. Both the Common Indian *Caprimulgus asiaticus* and the Franklin's *C. affinis* were plentiful, the former in orchards, gardens and cultivation, as well as in light grass and scrub jungle, while the latter, more locally common in scrub and deciduous jungle in broken country. Unhappily, developments over the last few decades have not been kind to nightjars: apart from pesticides reducing prey insects, the major threats have been clearing of hedgerows and grassy verges for cultivation; further degradation of scrub-covered, marginalised, highly eroded riversides and, of all things, the network of highways and increasing traffic on them! A great many collision deaths were reported in the 1970s and since then the almost total absence of nightjars on roads is troubling.

Sálim Ali's comment of "Common in teak and mixed deciduous forest areas" for the Indian Jungle Nightjar *Caprimulgus indicus* needs to be reconfirmed and areas beyond the Dediapada forests and the Dangs south of the Narmada valley examined, since Shivrajkumar Khachar with Dharmakumarsinhji had repeatedly mentioned hearing *C. indicus* in the heart of the Gir forest.

Sálim Ali's procuring a specimen of the Syke's Nightjar *C. mahrattensis* near Vadodara on estuarine ground suggests the possibility of this species occurring not only in Kachchh but in suitable habitats in north Gujarat and down the saline coastal pastures south of Vadodara. We have very little information on the European Nightjar *C. europaeus* which Sálim Ali found "a fairly common and abundant autumn passage migrant through Kutch" passing through between mid-September and mid-October. Amateur birdwatchers in Kachchh should make a special effort to reconfirm this observation.

There has been a recent report of a Ceylon Frogmouth *Batrachostomus moniliger* by Sanat Chavan of the Gujarat Forest Department from the Narmada valley, though I have seen no published report. If confirmed, this extends the range of this bird considerably north, all previous reports are from N. Kanara and south into Kerala.

Family APOPIDAE: Swifts

Swifts are great fliers and few birdwatchers spend time to observe them, with the result that what may seem to be vagrants or rare visitors are, in reality, regular visitors; in making this statement I have my record of the Pallid Swift *Apus pallidus* at Jasdan and Shivrajkumar Khachar's two sightings of the Large Whiterumped Swift *A. pacificus* at Jasdan and at Hingolgadh. The Alpine Swift *A. melba*, continues to be a regular bird, though "...of capricious movements, loose parties appearing suddenly from nowhere ... disappearing just as suddenly." Our birds are perhaps winter visitors from the Himalaya as well as foraging flocks from their nesting sites in the Western Ghats and possibly Mount Abu. Hingolgadh, Pavagadh and Mt. Girnar among other prominent hills are ideal places to observe the breathtaking flight of these swifts. The House Swift *A. affinis* continues to be "a common species over the entire area, though somewhat patchy, with old established colonies under arches and gateways everywhere". Sálim Ali's observation of nestlings taken from a nest of the "Striated Swallow" in Kachchh is in keeping with later researches by the late R. M. Naik at the MS University, Vadodara, where swifts accepted nest boxes. Sálim Ali's observation of differential sizes of the nestlings suggesting that brooding "had commenced with the first egg" substantiates my belief that these little birds spend nights inside their nests, an observation based on the traditional colony in the south gate of Hingolgadh. The Palm Swift *Cypsiurus parvus* has been noted over Jasdan in Saurashtra and Ahmedabad on distant forays from their headquarters in Palmyra palms which grow aplenty south of the Mahi River. Even a small, isolated cluster of these palms attract this swift, as I saw at the foot of Mt. Girnar. It is thus conceivable that if the palm is planted in other parts of the State, the breeding range of *C. parvus* would be extended and conversely if the palms get thinned out, there would be a corresponding constriction and a consequential decline in population; however, one point has to be borne in mind, palms must not be exploited — their fronds being heavily lopped explains Sálim Ali's "...but curiously enough not as common locally as the palms would warrant ....." The palms are, after all, themselves under severe human pressure.

Sálim Ali noted the lovely Crested Tree Swift *Hemiprocne longipennis* in wooded areas of today's Shoolpaneshwar Sanctuary south of the Narmada and at Songadh (where I doubt if it exists any longer) into the Dang forest. The high corridor forests so characteristic of the Gir in Saurashtra are still the home of this lovely swift. Possibly, imaginative afforestation along rivers may well extend this bird's range further north.

Family Trogonidae : Trogons

The Malabar Trogon *Harpactes fasciatus* is a bird of the Dangs in South Gujarat and Sálim Ali collected several specimens. While he suggested the possibility of its occurrence in the Rajpipla hill forests south of the Narmada, the status in the Dangs needs investigating. We have very little recent information on the bird. One hopes Sálim Ali's "fairly common in the Dangs" holds true today.

Family Alcedinidae: Kingfishers

All five species of Gujarat's kingfishers, the Lesser Pied *Ceryle rudis*, the Little Blue *Alcedo atthis*, the Storkbilled *Pelargopsis capensis*, the Whitebreasted *Halcyon smyrnensis* and the Blackcapped *H. pileata* have been placed under great pressure due to habitat disturbance, each in a special way. *C. rudis* is a bird of free-flowing streams and rivers, these are today either dried up or heavily polluted; *A. atthis* delights in reed-margined marshes, shaded free flowing streams and rocky tidal pools: the first two habitats are considerably disturbed and today this little gem of a bird is perhaps best seen along the sea coasts. *P. capensis* "absent in Kuchchh and Saurashtra", has much of its forested habitats along the eastern hill areas of the State heavily disturbed and the former perennial streams are choked with silt and quite unfit for fish; a special investigation is called for to ascertain whether it still continues to be "Not uncommon on forest streams" ranging from Balaram in northern Gujarat south through Chota Udaipur, Jambughoda, the Rajpipla hills to the Dangs. *Halcyon pileata* recorded by Sálim Ali on the Ambika River of south

Gujarat has been seen all along the coast in recent times, suggesting its favoured former mangrove habitat extended to the Kori Creek in western Kachchh. The species is decidedly very scarce. Only *H. smyrnensis*, more catholic in diet, is holding out well — at times at great distances from water. Sálim Ali is rather unclear on the subject of the entire group's nesting season in Gujarat. I believe all our kingfishers nest during the hot season, no doubt due to the easy availability of fish in drying river pools and prior to the heavy rains of late Júne and July, when flood waters would drown nest holes.

The presence or absence of kingfishers would, I suspect provide indications of the quality of water in Gujarat and the success of afforestation both on the hills and along the coastline.

Family MEROPIDAE: Bee-eaters
Family CORACIDAE: Rollers
Family UPUPIDAE: Hoopoes

Sálim Ali records the Bluecheeked Bee-eater *Merops superciliosus* thus "Evidently an autumn passage migrant over Kutch ... like the Kashmir Roller". Actually Kachchh and Saurashtra and perhaps north Gujarat are on the fringes of its breeding range since it nests regularly outside Bhavnagar as first recorded by Dharmakumarsinhji. I have observed several pairs excavating in May in 1948 near Jasdan and very much later, with Shivrajkumar Khachar I saw a large colony at Nir on the edge of the Great Rann. The bird certainly is both a passage migrant and a winter visitor over much of Gujarat. Interestingly, this bee-eater spends a lot of time gliding high in the air capturing insects carried up by warm currents, quite unlike the Green Bee-eater *M. orientalis* which makes sallies from an exposed perch. The larger bee-eater is, therefore, less seen than its smaller cogenitor which is a common resident over much of the State. There is, however, considerable local movement, with birds scattering during the SW monsoon. I have seen *M. orientalis* snapping up small crabs at the edge of the tide on Beyt.

The Bluetailed Bee-eater *M. philippinus* closely resembles *M. superciliosus*. In fact, the two were considered to be subspecies. *M. philippinus* has been reported from central and south Gujarat though we need to ascertain whether it nests in these areas. I found a cluster of nest holes in the chalk heaps of the Gujarat State Fertiliser Corporation outside Vadodara which, I suspect, belonged to this species. The European Bee-eater *M. apiaster* has been recorded by Shivrajkumar Khachar at Jasdan and I am under the impression there have been recent records from Kachchh — at best, this beautiful bird is most probably a scarce passage migrant in autumn. The last of Gujarat's bee-eaters is the Bluebearded Bee-eater *Nyctyornis athertoni* which Sálim Ali heard in south Gujarat but concludes "Confirmation is desirable."

In our area we have two rollers, the European Roller *Coracias garrulus* an autumn passage migrant "abundant between second week and end of September and gone by end of October". The degradation of grasslands and the infestation by *Prosopis chilensis* in its favoured habitats of Kachchh, North Gujarat and Saurashtra must, most assuredly, place a heavy strain on the migrating birds. The Indian Roller *C. benghalensis* nests wherever there are large trees with cavities and after breeding, spreads out into agriculture throughout Gujarat. Of late, numbers have appreciably declined, no doubt on account of pesticides and the destruction of suitable nest trees. The decline needs to be monitored.

The Hoopoe *Upupa epops* is resident in better wooded areas of mainland Gujarat - I have a pair nesting in a nest box at my Gandhinagar residence. Elsewhere, it is "frequent" over the entire area during winter when there is an "influx of immigrants from the north". Trees with holes and buildings with cavities in walls are important for the continued proliferation of this handsome bird.

Family BUCEROTIDAE: Hornbills

Gujarat has only one hornbill, the Common Grey Hornbill *Tockus birostris*. The hornbill was found in better wooded areas from near Palanpur in north Gujarat, through Vadodara and south to the Dangs. It also was found in the Gir forest of Saurashtra. The exact situation needs confirmation since the birds are persecuted for alleged medicinal values and their need for large trees with nesting cavities which are growing scarce.

Family Capitonidae: Barbets

Three species of these arboreal frugivorous birds have been recorded in Gujarat. The sparrow-sized Crimsonbreasted Barbet *Megalaima haemacephala* continues to be a common resident throughout the State. The exact status of the other two requires confirmation. The large green Barbet *M. zeylanica* was "abundant and noisy where occurring" but the proviso "restricted to well wooded country" qualified its distribution in mainland Gujarat to select patches, many of which have lost the large trees which were so universally valued as avenue trees, particularly the *Ficus*. I recollect hearing this barbet in Mehsana at the railway station in the early fifties. I presume the Small Green Barbet *M. viridis* still continues to be "restricted to moist decidous forest in the Ghats foothill country, and here not uncommon". However, great changes have taken place — certainly not for the better —and we need updated information on this and other forest species in south Gujarat.

Family Picidae: Woodpeckers

Sálim Ali lists ten species of woodpeckers for Gujarat. The most vulnerable among them are the woodpeckers associated with forest country, particularly of the hill areas of Rajpipla and the Dangs. These are the Rufous Woodpecker *Micropternus brachyurus*, the Small Yellownaped Woodpecker *Picus chlorolophus*, the Great Black Woodpecker *Dryocopus javensis*, the Heartspotted Woodpecker *Hemicircus canente*, the Blackbacked Woodpecker *Chrysocolaptes festivus* and the Larger Goldenbacked Woodpecker *C. lucidus*. All the above listed woodpeckers were recorded in the then well timbered hill country south of the Narmada; forest degradation in the last fifty years will have greatly reduced their ranges, if not striking them off the Gujarat list. I am happy to say that I was shown a pair of *Hemicircus canente* and observed in flight a *Dryocopus javensis* in the Dangs in the late eighties. Exact information, however, on these and the remaining four species is urgently required. Indeed, the presence and numerical abundance of all these woodpeckers would confirm the biodiversity build-up through forest regeneration.

Of the remaining four species, the Lesser Goldenbacked Woodpecker *Dinopium benghalense* continues to be "not uncommon" in mainland Gujarat and the Gir forest of Saurashtra, the Pigmy Woodpecker *Picoides nanus* is perhaps often overlooked (as it seems to have been in the Pictorial Guide) and should still be "Common" in the teak tracts of Gujarat as well as in the Gir forest frequently being passed over as the still widespread Yellowfronted Pied Woodpecker *Picoides mahrattensis*. This last species has lost ground over much of Saurashtra with the felling of former thickets of *Acacia nilotica*, to which it seemed to have been partial. We need the latest information on the situation in Kachchh. I anticipate this woodpecker's comeback with the excellent regeneration and active plantation by the Forest Department of the "desi" babool.

The fourth, and last of our woodpeckers, the Wryneck *Jynx torquilla* is a winter visitor which, I regret to record, is no longer "fairly common", though the exact position can be commented on only by very regular birdwatching which, despite the large number of amateurs, is unhappily not being done.

AN OVERVIEW OF THE BIRDS OF GUJARAT

The Families which follow contain the bulk of species, both resident and winter migrants, which are more visible around homes and in cultivation. The majority live in and among vegetation, be it herbaceous or the tallest of trees, and build nests on the ground among grass, in shrubs and up in trees; several nest in holes in walls, or gnarled trees. Their food ranges from seeds, nuts and fruit to insects and many very readily come to feed on "chapati" crumbs. This large assemblage of Families and still greater number of species are all grouped into a single Order: Passeriformes and in popular parlance are known as Song Birds. The purpose of this introductory insertion is to emphasize that few ornithologists seem to be over concerned about the need for conservation of these more widely dispersed and "common place" birds; this is perhaps so because they occupy no very distinct habitat, and preferences if any are very subtle. There has been a very dramatic decline in numbers of a great many species, while others have had their ranges reduced. Unlike the large, more visible birds on whom considerable attention has been focused, song birds are not long lived and this adds to the great urgency of taking on very immediate conservation action — we do not have time for the luxury of scientific research. Fortunately, what is pleasing to human beings is of advantage to these birds — well maintained avenues, good shady gardens — even pergolas with flowering climbers or a collection of foliage plants in pots suffice; food on bird tables and nest boxes are gratefully accepted, and above all, a popular awareness of birds will register any fading of the morning birdsong, which in turn will generate widespread alarm. A richly endowed avian environment is great for us human beings since birds, especially the vibrant song birds with their high metabolic rates and rather short lifespans need a clean environment to live their vigorous lives in and respond very quickly to changes. As such, their plentitude or paucity may well reflect the state of the environment, providing early warning of possible deterioration. More significantly, every individual can do something which is not possible for action to conserve, say the Great Indian Bustard. We now resume our discussion of Families with a very lovely bird, one of a group so brightly coloured that they are often referred to as Jewel Thrushes.

Family Pittidae: Pittas

Sálim Ali did not see or hear the Indian Pitta *Pitta brachyura* but comments "Possibly arrives in suitable localities, as elsewhere, as a forerunner of the SW monsoon". He cites Dharmakumarsinhji having "found it, widespread and calling frequently in the Gir Forest". Pittas turn up in May and June in the smallest of shady gardens or under dense vegetation along hedgerows and in eroded riverain country. Dharmakumarsinhji had reported a pitta nesting in jungle on the sacred Shetranjaya Hill in Saurashtra and I showed Shivrajkumar Khachar two juvenile pittas still being fed by parents in the Hingolgadh scrub forest. Since few birdwatchers are out during the monsoon, *P. brachyura* is likely to be overlooked. The Dangs forest is an eminently suitable pitta habitat but the tribal children with their lethal catapults are a nemesis to ground and shrub birds. Calling in secondary teak forest and suspected to be nesting in Panch Mahals north of the River Mahi, 20th July 1996. There have been confirmed reports of the bird nesting in the Gir forest.

Family Alaudidae: Larks

Gujarat is great lark country. The Redwinged Bush Lark *Mirafra erythroptera* continues to be "common" in scrub covered hummocky country and edges of cultivation, though less widespread in southern Gujarat. The Singing Bush Lark *M. javanica* is certainly no longer "not uncommon", since the prime grasslands it preferred are either grazed over or planted with *Prosopis chilensis*. More careful observations on all larks are necessary as they are quite confusing, especially the Eastern Skylark *Alauda gulgula*, of which Sálim Ali had this to say — "Fairly common in suitable localities on moist grassy margins of tanks, etc." Novices and a good many otherwise recognised bird watchers tend to gloss over the larks as a group, so more serious attention needs to be given to the family as a whole. Gujarat has the distinction of possessing all three crested larks. The Crested Lark *Galerida cristata* is still "fairly" common in more arid portions of the area, in Kutch, N. Gujarat on the edges of the Great and Little Ranns. It is also plentiful on the Gulf of Kachchh islands particularly Ajad and Beyt. The Sykes's Crested Lark *G. deva* is more partial to the

Deccan trap plateaux of Saurashtra and Kachchh, where it shares its habitat with the Rufoustailed Finch-Lark *Ammomanes phoenicurus*. The Malabar Crested Lark *G. malabarica* was recorded up to south Gujarat in the Western Ghats type of country. Dharmakumarsinhji extended the range further north to the edges of saltpans near Bhavnagar and I have seen pairs on halophytic meadows on Pirotan Island near Jamnagar. The bird is, however, totally absent from interior Saurashtra and much of Gujarat. Sálim Ali recorded the Sand Lark *Calandrella raytal* along seacoasts of Kachchh, but it is now established that the bird in a very distinct, dark form occurs on the Saltpans of Bhavnagar — there is all possibility of the bird occurring across the Gulf of Khambhat in Gujarat; the lighter Kachchh form occurs on coastal dunes and sandy islands south of the Gulf of Kachchh till Beyt Dwarka off Okha. The Blackbellied Finch-Lark *Eremopteris grisea* is a common resident which has found habitat degradation helpful in extending its range into areas otherwise not normal for it. The Blackcrowned Finch-Lark *E. nigriceps* was first recorded by Shivrajkumar Khachar during bird banding at Kuar Beyt in the Great Rann, and later he saw a flock at Jasdan in Saurashtra; perhaps *E. nigriceps* is more common than believed, being overlooked among the ubiquitous *E. grisea*; I have yet to see the bird and its status is to be confirmed. The huge flocks during winter of the Short-toed Lark *Calandrella cinerea* in open country seem to have thinned considerably, undoubtedly on account of overgrazing reducing grass seed on which the immense flocks depended. Change in agriculture patterns with groundnut and cotton largely replacing the former extensive millet and "bajri" along with intensive farming practices obliterating all weeds within crops and grass verges between plots, have considerably depleted food supplies. The large Desert Lark *Alaemon alaudipes*, earlier known more expressively as the Hoopoe Lark, continues to be free of any threat on the barren sandy "Pats in the Rann". It is, however, yet to be seen what effect the burgeoning salt industry around the Little Rann will have on this fine lark, but for the time being the species, it would seem, is not in any danger, living as it does in the most hostile of habitats.

Family Hirundinidae: Swallows

Sálim Ali had recorded seven species in his Gujarat Surveys. In those days there was only one species of Sand Martin, *Riparia riparia*, but since he goes into trinomials, i.e. subspecies, it is apparent that he only came across the resident subspecies and that too along the larger sandy rivers of mainland Gujarat. The now separate species Plain Sand Martin *R. palaudicola* is locally common, nesting in large colonies on all the major rivers, but more widespread in Saurashtra and Kachchh, with the winter migrant not reported by Salim Ali, the Collared Sand Martin *R. riparia*. This last species is plentiful, with other swallows hawking for aerial insects over water throughout Gujarat. The Dusky Crag Martin *Hirundo concolor* is still "Common" around rock escarpments, forts and large monuments where it places its half-cup shaped nest of mud pellets on narrow ledges or attaches it to the wall under arches; it has readily taken to large new buildings like the Vidhan Sabha and the Secretariat blocks in Gandhinagar and the Sardar Patel Institute of Public Administration in Ahmedabad. The very similar, and largely overlooked, Crag Martin *H. rupestris* is a winter visitor to be looked for at Hingolgadh, Pawagadh, Mt. Girnar and Salher Fort in south Gujarat, where also Sálim Ali collected the black and white House Martin *Delichon urbica*, a bird I have yet to see away from the Himalaya. Both the swallow *Hirundo rustica* and the wintering race of the Redrumped Swallow *H. daurica* are common in season, collecting in large flocks at communal roosts in reed beds and sugarcane. The resident race of *H. daurica* continues to breed "freely" all over the State and in particular in Gandhinagar where pairs have appropriated unfinished bungalows. If any species has benefited by "development" it is the Cliff Swallow *H. fluvicola* which has taken to the many large concrete bridges constructed over rivers like the Vatrak, Mahe, Narmada, etc. Here the nests are in packed colonies, with the owners swarming like bees disturbed at a hive! Elsewhere in Saurashtra and Kachchh, they are found in lesser numbers with a patchy distribution. The lovely Wiretailed Swallow *H. smithii* is uniformly distributed over the State, though my general impression is that it is less common than a couple of decades ago on account, no doubt, of the general drying up of water and the pollution of what remains in the channels in cultivation.

Family Lanidae : Shrikes

Of the nine species of shrikes occurring in the Subcontinent, Sálim Ali records six. The Grey Shrike *Lanius excubitor* he found resident and common. "Met with singly or in pairs in sparsely scrubbed semidesert country interspersed with cultivation". Over the years, the numbers have declined significantly and one might like to understand why. The areas this shrike specifically seemed partial to were certainly not free of heavy grazing. I suspect the decline is on account of felling of even the thin thorny trees, and later their replacement by *Prosopis chilensis*, which forms dense thickets. *L. excubitor* needs open spaces with stunted trees to use as vantage points and to build nests in. The Baybacked Shrike *L. vittatus* has recorded a dramatic decline, which to my mind is due to the widespread use of pesticides. This pretty little shrike was a bird of more intensive cultivation; it also seems to have a preference for, as indeed Sálim Ali notes most specifically, "Affects semidesert country ... but slightly better wooded — with babool groves, etc." The babool tree was the first to be wiped out. *L. vittatus* is certainly no longer "fairly common" nor is it as widespread as it formerly was. During the last two decades, there has been a remarkable rehabilitation of the native *Acacia nilotica* and we may anticipated a resurgence in this attractive shrike's numbers. The widespread use of pesticides too must be seen as having been instrumental in reduction of all shrikes since they are entirely carnivorous — large insects and small reptiles being their mainstay. The very similar Redbacked Shrike *L. collurio* is one of those autumn passage migrants which pass over Kachchh, North Gujarat and Saurashtra from mid September to the end of October. Sálim Ali records it as "a not uncommon passage migrant (regular ?)" but I have, over the years, come to the conclusion that it is indeed not a regular passage bird; my doubt is substantiated by Sálim Ali's own questioning of the status of this shrike. During the first birdbanding operation at Changalra, Kachchh, we saw not a single bird, let alone mistnet any. I have seen *L. collurio* at Hingolgadh during what might have been an especially heavy inflow. The Rufousbacked Shrike *L. schach* continues to be fairly common, though the breeding range appears to have got restricted, particularly in the drier parts of Kachchh and Saurashtra and we need to keep an eye on the status of our resident, breeding subspecies. The wintering subspecies continues to be fairly plentiful. The Pale Brown Shrike is now considered a subspecies of the Redbacked Shrike and this is now scientifically named *L. collurio phoenicuroides*, while a very similar subspecies is named *L.c. isabellina.* Both of these are winter visitors to open cultivation and drying edges of jheels where they can be confused with the very similar, less common winter visitor the Brown Shrike *L. cristatus*. Shrikes as a group need some qualitative observation. Their populations have undoubtedly declined due to a variety of man-induced pressures. Special attention needs to be given to our three resident shrikes *L. excubitor*, *L. vittatus* and *L. schach*.

Family Oriolidae : Orioles

Gujarat has two species of Orioles : The Golden Oriole *Oriolus oriolus* and the Blackheaded Oriole *O. xanthornus*. The former is widespread among trees in cultivation, more so during winter; it is, however, a resident nesting species in Gujarat, Saurashtra and also Kachchh, though in Kachchh needs confirmation. Sálim Ali's notation "Uncommon in Kutch; sporadic solos frequent elsewhere. Apparently only a winter visitor" is puzzling. *O. xanthornus* was recorded as "common and resident" south of the Narmada in well wooded country. It occurs in the Gir forest, though its present status needs confirmation.

Family Dicruridae: Drongos

The Black Drongo *Dicrurus adsimilis* (this specific nomenclature has been recently changed!) is no longer "Common" as in the earlier part of the century. Numbers have declined, no doubt on account of widespread use of pesticides. I can confirm Sálim Ali's observation of birds migrating to and from Sind — what he recorded at Nir on the edge of the Great Rann, I have seen on Pirotan and other islands to the south of the Gulf of Kachchh. Nesting is, as noted by Sálim Ali, during the hot season. It is more a bird of open country, capturing much of its insect prey from the ground, over crops and grass, unlike the wintering, though superficially very similar, Grey Drongo *D. leucophaeus.* This wintering species prefers large well crowned trees and is entirely arboreal, spending much time "flycatching" inside the trees. It is most certainly more widespread than supposed; Sálim Ali does not mention Saurashtra and about Kachchh says "Not met with in Kutch. I have examined a vagrant shot in the well-wooded grounds of Vijay Vilas Palace, Bhuj". Actually this drongo is common at Gandhinagar, and in the wooded gardens of Ahmedabad. It is a regular visitor to Jasdan in Saurashtra and palace compounds of Gondal should be highly favoured habitats, as would indeed be the tall corridor forests of the Gir. A talented mimic, the Whitebellied Drongo *D. caerulescens* is a "common, resident" of the well wooded valleys of the hill country stretching from Mt. Abu in the north to the Dangs in the south. During the non-breeding season there is a wide dispersal into Saurashtra and presumably Kachchh, from where there seem to be no records! Kachchh however, has the distinction of a record of a wintering Haircrested Drongo *D. hottentotus* procured by MKS Himmatsinhji in the Vijay Vilas compound at Mandvi. There are all possibilities of this species occurring in winter in other well wooded locations, especially in the Rajpipla and Dangs forests. It is in these hill forests that the spectacular Greater Racket-tailed Drongo *D. paradiseus* successfully evades the catapults of tribal boys, living high up in tall forest trees. Sálim Ali, however, records an interesting observation of one of these fine drongos "imitating to perfection the call of a Shikra, only to be chased, killed and eaten by the hawk!"

Family Artamidae: Swallow-Shrike

Sálim Ali makes no mention of the Ashy Swallow Shrike *Artamus fuscus,* nor have I seen the bird in Gujarat though Lalsinhbhai Raol has a record of watching three birds near Rajpipla and there is every likelihood of it occurring in suitable hill forests south of the Narmada.

Family Sturnidae: Mynas and Starlings.

Apart from the specimen collected by Sálim Ali near Ajwa of the Greyheaded Myna *Sturnus malabarica* I have no recent information. Even Sálim Ali fails to make any comments on the species' status. I would, however presume *S. malabarica* is more plentiful than supposed, spreading north in nonbreeding season. Both winter migrants, the Rosy Pastor *Sturnus roseus* and the Starling *S. vulgaris* continue to be as in the 1940s : The former "Common and abundant" and the latter "Evidently an uncommon straggler in winter" though during some winters I have noted *S. vulgaris* as common, at other times totally absent. The Blackheaded Myna *S. pagodarum* continues to enjoy the status as noted by Sálim Ali "Uncommon, capricious and local in Kutch; fairly common in Saurashtra and Gujarat". I would qualify this by considering it more plentiful in Gujarat, where there are still many old trees with cavities for nesting in. Nest boxes are readily occupied and the species would indeed make up any decline if provided with them. Both the Common Myna *Acridotheres tristris* and the Bank Myna *A. ginginianus* are common, the latter fairly patchy in distribution, this no doubt on account of its tendency to nest colonially. The availability of natural and artificial nest holes encouraging colonial nesting could restrict its spread. Both mynas have become commensal on human beings, finding food and nesting locations in the most densely populated urban areas. The Jungle Myna *A. fuscus* should be looked out for in the better forested hill country of south Gujarat.

Family CORVIDAE: Crows, Tree Pies

Half a century ago, the Indian Tree Pie *Dendrocitta vagabunda* was "Common in all the better wooded portions of the area" but during the last two decades I have noted a decline in numbers. For instance, I do not recall noting a Tree Pie in my otherwise bird-rich Gandhinagar neighborhood. The decline is difficult to explain, though I suspect faulty monoculture practices in forestry and the replacement of large avenue trees bearing figs and other fruit could well be one of the reasons. It would be interesting to note whether Sálim Ali's comment for Surat Dangs "... it is one of the five commonest bird species in bamboo and mixed deciduous forest ..." still holds true. Wherever found, the bird is fairly vociferous and can be easily recorded. Birdwatchers in Kachchh may like to confirm whether the Ranns have indeed insulated the district from *D. vagabunda*. The House Crow *Corvus splendens* continues to prosper right across Gujarat while the all black Jungle Crow *C. macrohynchos* has a curiously patchy distribution in Gujarat and Saurashtra, where it is entirely missing from the central parts of the peninsula, occurring in the Gir, Girnár, and on Beyt and along the northern coast of Saurashtra till Jamnagar. Its status in Kachchh needs verification. To see the magnificent Raven *C. corax* one must go to the Kachchh edges of the Great and Little Ranns. Our knowledge is no further improved beyond Sálim Ali's, who has little to record about its exact status in our area. I dimly recollect Shivrajkumar Khachar mentioning the Brownnecked Raven *C. ruficollis* during one of his visits to Kachchh — I mention this merely to urge the several very knowledgeable birdwatchers of Bhuj to keep a lookout.

Family BOMBYCILLIDAE: Waxwings, Silky Flycatchers.

Sálim Ali makes no mention of the enigmatic Grey *Hypocolius ampelinus* of which he himself had collected a specimen in Kihim, south of Bombay. Bird netting in the sixties yielded a pair at Pachham Island "thirty years after his own ... at Kihim. Had he been alive today, he would have been glad to learn that (it) has been recorded for five seasons running from January 1990 to November 1994. During the Bird Migration Study and the Grassland Ecology Projects young J.K. Tiwari reported over a hundred *H. ampelinus*". I quote MKS Himmatsinhji. With Tiwari now in Kachchh I hope to see my first *Hypocolius*!

Family CAMPEPHAGIDAE : Cuckoo Shrikes and Minivets.

I have yet to see a Pied Flycatcher-Shrike *Hemipus picatus* and the large Wood Shrike *Tephrodornis virgatus* in Gujarat. Sálim Ali records both in the Surat Dangs. Their exact status needs confirming. The Common Wood Shrike *T. pondicerianus* appears to be holding out all over the State. They are largely overlooked by most birdwatchers who give less attention to bird calls. The Large Cuckoo-Shrike *Coracina novaehollandiae* and the smaller Blackheaded Cuckoo-Shrike *C. melanoptera* are both best recorded by their calls. My impression is that cuckoo-shrikes are more widespread as monsoon nesting species than is believed. *C. melanoptera* is quite vociferous in the scrub jungle around Hingolgadh and I have heard it in the Sundarvan Nature Centre in Ahmedabad. The former tends to wander a great deal outside the nesting season, though nesting records are needed. Sálim Ali emphatically says both are "absent from Kutch". There are three minivets listed for Gujarat — the Scarlet Minivet *Pericrocotus flammeus*, the Small Minivet *P. cinnamomeus* and the Whitebellied Minivet *P. erythropygius*. The Longtailed Minivet *P. ethologus* of the middle elevations of the Western Himalaya may straggle south into the hill forests adjoining Mt. Abu. *P. flammeus* is "Resident. Common in hilly bamboo and mixed deciduous forest" of south Gujarat, while *P. erythropygius* is a bird of open thorn jungles "Resident : Common in Kutch, though rather patchy and local". It should also be looked for east of the

Little Rann in suitable tracts, while in Saurashtra the bird is found in grasslands of northern Gir and the Hingolgadh jungle. Sálim Ali's "rather patchy and local" in Kachchh is because, I suspect, the importance of grass admixed with the thorn scrub being to the species' preference. At Hingolgadh, as in Kachchh, both *erythropygius* and *cinnamomeus* share the same habitat, and I have had the opportunity of closely observing both minivets — it was evident that *erythropygius* depends heavily on slender green grasshoppers, particularly plentiful in the first flush of tender grass, to feed the young, while *cinnamomeus* feeds its young on green grubs and minute black beetles. The former exclusively built its nest in the light crowned *Acacia senegal* while the latter used more densely foliaged *Acacia nilotica, Tamarindus indica*, etc. *P. cinammomeus* is found throughout Gujarat, overlapping the ranges of *P. erythropygius* in the drier northwest and *P. flammeus* in the moist, well wooded south.

Family Irenidae: Ioras and Leaf Birds

Gujarat has two species of Ioras, the Common Iora *Aegithina tiphia* and Marshall's Iora *A. nigrolutea*. There has been some doubt about *A. nigrolutea* being a distinct species, but in Gujarat the two occupy very distinct habitats, the former being "fairly common in the well-watered portions of Gujarat inhabiting cultivated country interspersed with large trees, groves about villages, roadside avenues and wooded compounds in towns, as well as light deciduous forest". It is also found in the orchard country of southern Saurashtra from Junagadh at the base of Mt. Girnar and the arc of the Gir hills. *A. nigrolutea* occurs all over the drier parts of Saurashtra, north Gujarat, and of course Kachchh where, as at Hingolgadh, it "is common ... to the complete exclusion of *tiphia*". Sálim Ali confirms my own observation as follows "I found the call notes of Marshall's Iora distinct from those of the common species ... I found the notes of the two so distinct, in fact, that after having met the Common Iora all through Gujarat, I detected the presence of this species at once by ear ..." In my case, having grown up listening to *A. nigrolutea* I immediately recognised *A. tiphia* by ear in Ahmedabad and in my compound trees at Gandhinagar. It would be interesting to examine the interaction of the two species along the habitat interface, as along the northern edge of the Gir forest in Saurashtra or at Radhanpur in north Gujarat. Sálim Ali notes that the Goldfronted Leaf Bird *Chloropsis aurifrons* is "Frequent in deciduous forest", but did not come across it north of the Narmada valley. However, my knowledgeable friend Lalsinh Raol personally told me he watched one at Chhota Udaipur and the bird undoubtedly should be occurring in forested locations well upto the Pavagadh hill in Panch Mahal. The Goldmantled Leaf Bird *C. cochinchinensis* has been recorded by Sálim Ali at Pavagadh and further south in "opener country than the Goldfronted species". Perhaps, both chloropses are commoner than believed, being largely overlooked among the tall, densely crowned trees they inhabit. I have yet to see either in Gujarat, though I must admit I have had few opportunities of intensive birding in Gujarat's hill forests.

Family Pycnonotidae : Bulbuls

Sálim Ali saw only one pair of the Redwhiskered Bulbul *Pycnonotus jocosus* at Waghai in the Dangs. I myself have never seen this jaunty bulbul, though there are very suitable habitats all along the eastern hill country up to Mt. Abu where it is fairly common. The Gir forest too is eminently suitable country. The Redvented Bulbul *P. cafer* continues to be "Common throughout the area in every biotope save pure desert (eg. the Great Rann) ..." Numbers, however, have shown a perceptible decline around Hingolgadh, no doubt suggesting degradation of the once strictly protected thorn scrub. The Whitecheeked Bulbul *P. leucogenys* is common in association with *Salvadora persica* and *S. oleoides*; as a result it often shares a habitat with *P. cafer* where suitable semidesert country ramifies into agriculture, as up estuaries of the major rivers. On the Gulf of Kachchh islands, it is the main bulbul species. The Whitebrowed Bulbul *P. luteolus* inhabits dense scrub in deeply eroded river banks of mainland Gujarat, being totally absent in Saurashtra and Kachchh. Sálim Ali recorded it in Mehsana District north of Ahmedabad, and I have seen it as fairly numerous in the tangled vegetation and trees of the Laxmi Vilas Palace grounds in Baroda. A pair was resident in a small patch of lantana and grass in the Sundarvan Snake Park in Ahmedabad, suggesting that this bulbul is very parochial and continues to thrive in the most circumscribed of suitable habitats.

Family MUSCICAPIDAE : Babblers, Flycatchers, Warblers, Thrushes and Chats

This is a large family and we shall discuss the species under the subfamilies as by Sálim Ali in his paper, following the same sequence though priority has been reshuffled in the SYNOPSIS and the PICTORIAL GUIDE.

i. Subfamily MUSCICAPINAE : Flycatchers

Flycatchers as a group have registered a sharp decline in the intensely cultivated parts of the State, both on account of indiscriminate use of pesticides and the clearing of shrubberies on edges of fields. Degradation of habitat, thanks to over grazing and extraction of brushwood for fuel, has reduced suitable habitats elsewhere; in Kachchh, large areas of northern Gujarat and parts of Saurashtra, the exotic *Prosopis chilensis* has overrun the countryside almost to the exclusion of indigenous plants and cannot but exert a limiting role, adversely affecting a multitude of insectivorous birds, flycatchers, warblers, and babblers among them. The Spotted Flycatcher *Muscicapa striata*, an autumn passage migrant through Kachchh and Saurashtra, continues during "the height of passage, between 2nd and 4th week of September to be fairly common." Sálim Ali presumed the Brown Flycatcher *M. latirostris* to be a resident in the Dangs, but it has been recorded in the Gir forest and at Jasdan in Saurashtra by Shivrajkumar Khachar: the species' exact status seems unclear. I was shown one by Sálim Ali in his Bandra garden during the cool season, so presumably this forest flycatcher wanders considerably outside its breeding season. The Redbreasted Flycatcher *M. parva* is no longer as "fairly common" a winter visitor as a few decades ago, when its clicking sound was to be heard all over Gujarat in farmland, suburban compounds and every type of jungle. Lalsinhbhai Raol personally informed me of his recording the Whitebrowed Blue Flycatcher *M. superciliaris* in the Jessor hills of northern Gujarat and again in a temple grove beside the Hathmati River north east of Ahmedabad. Sálim Ali does not mention this species and quite apparently, it is more often than not overlooked for the more widespread and very similar sounding *M. parva*. The Tickell's Blue Flycatcher *M. tickelliae* is a common breeding bird in the Girnar, the Gir and the Dangs, as well as the shaded hill streams of eastern Gujarat. Sálim Ali notes it as one among the commonest five species in bamboo and mixed deciduous forests of south Gujarat. Outside the nesting season this flycatcher disperses widely and can be expected in shaded locations all over Saurashtra and Gujarat, though records from Kachchh are lacking. The Verditer Flycatcher *M. thalassina* from the mid elevations in the Himalaya is a winter visitor to mainland Guajarat. It has been recorded in the Gir forest and at Jasdan in Saurashtra by me. The Greyheaded Flycatcher *Culicicapa ceylonensis*, Salim Ali presumed to be a winter visitor, "not common". This lively little bird is a regular winter visitor to be looked for in groves of large trees, and is quite regular and certainly not uncommon. In Saurashtra it has been seen by me in the Gir and Girnar forests as well as near Jasdan, it is a regular winter visitor to Sundarvan Park, Ahmedabad. Birdwatchers in Bhuj should keep a look out for this active little bird in the Vijay Vilas compound at Mandvi. Both the Whitebrowed Fantail Flycatcher *Rhipidura aureola* and the smaller Whitethroated Fantail Flycatcher *R. albicollis* are present in mainland Gujarat, absent in Kachchh and the former occurring in Saurashtra where its range today has become restricted to the Girnar and Gir Forests though it was a common bird around Jasdan in 1940s. Where ever still found, it is partial to mango groves and forest clearings. Both fantails can be seen in Ahmedabad and around Baroda, though *R. aureola* prefers more open situations with large trees, while *R. albicollis* is restricted to dense shrubberies and undergrowth though, as Sálim Ali states, "in borderline localities the two are sometimes found in the same patch and even in the same tree!" For the Paradise Flycatcher *Terpsiphone paradisi* Sálim Ali says "The status of the Paradise Flycatcher needs to be determined". He hazards a guess that it "is resident and breeds in the better wooded parts, e.g. Navsari district, Rajpipla and Surat Dangs, and it has recently been reported to do in the Gir forest ... by K.S. Dharmakumarsinhji." I have seen it during the breeding season in the Girnar Forest, a pair was regularly nesting in the lovely Ramparda Vidi near Wankaner and currently this flycatcher is a regular breeding bird in the Indroda Park outside Gandhinagar. During the non-breeding season, birds turn up almost throughout the State many of the individuals no doubt being migrants from the North. The Blacknaped Flycatcher, *Hypothymis azurea* is recorded by Sálim Ali as being "Resident. One of the commonest birds in bamboo, teak and mixed deciduous forest" of south Gujarat, but non-breeding birds appear to scatter widely as indicated by Sálim Ali's record from Dwarka, and mine from Jamnagar and Rajkot. In the Gir forest this Flycatcher presumably breeds and is more plentiful than believed.

ii. Subfamily TIMALINAE: Babblers

Of the 124 species on the Indian List under this subfamily Gujarat has only eight. Of these, the Spotted Babbler *Pellorneum ruficeps*, the Slatyheaded Scimitar Babbler *Pomatorhinus* and the Quaker Babbler *Alcippe poioicephala* are restricted to the moister hill forests south of the Narmada valley, though there is a very early record of the last species from Rajkot! I would personally like to question this, though Sálim Ali refers to it without comment. These three forest Babblers seem to have been fairly common, though we need qualitative confirmation since there has been considerable degradation and Songarh so repeatedly mentioned in Sálim Ali's paper no longer has forest worth mentioning. It may be pointed out that *Pomatorhinus horsfieldi* occurs far to the north at Mt. Abu and so there are possibilities of small populations occurring in remnant jungle in the area in between. The tiny Rufousbellied Babbler *Dumetia hyperythra* was "Common in scrub jungle, particularly where cut up by ravines" all along the eastern hill country from near Palanpur in north Gujarat down south and along the deeply eroded riversides of the major rivers like the Mahe, Narmada and Tapi. In Saurashtra the bird was recorded by Dharmakumarsinhji at Bhavnagar, and by Sálim Ali near Kodinar south of the Gir forest. I have seen this Babbler near Sasan in the Gir. Elsewhere in Saurashtra, semi-arid parts of north Gujarat bordering the Rann and Kachchh these shrubbery loving babblers are absent. The attractive Yelloweyed Babbler *Chrysomma sinense* continues to be "not uncommon" over the entire State though it disappears where overgrazing thins grass and tangled shrubberies; over much of central Saurashtra the bird has been extirperated and its status in *Prosopis chilensis* overgrown parts of Kachchh needs confirmation.

The three remaining babblers are widespread and are still holding out well. There is considerable overlapping of ranges and a detailed study of the three would reveal fascinating species habitat preferences. The Common Babbler *Turdoides caudata* is "Common over a wide range of terrain from right away on the barren Rann through sandy cultivation with scrub interspersed, to fairly thick but dry thorn and scrub jungle... Dry sandy ravines bordered by *Capparis*, *Zizyphus*, *Acacia* and *Prosopis* are its favoured haunts". This habitat occurs over Kachchh, much of northern Saurashtra and the agricultural plains of Gujarat all the way south to the Mahe estuary and perhaps along the saline coastal flats till the Narmada; the eroded "badlands" along these rivers provide favoured habitats well into otherwise unacceptable areas. Sálim Ali has frequently mentioned the Rann, an impression being gained that it is an arid, dry, lifeless desert of perhaps sand and rocks; that the Ranns are unique geographical features is undoubtedly a fact, the uniqueness has indeed been indicated by Sálim Ali in his Birds of Kachchh : the uniqueness is that the Ranns are the most expansive of saltpans on earth and periodically they get inundated by water blown up by strong southwest monsoon winds from the sea or by especially high equinoxal tides spilling over; heavy rains in Rajasthan and north Gujarat send floods down rivers like the Luni, the Banas and the Saraswati which debouch onto the Ranns turning them into shallow seas of clear but highly saline water. At times, great expanses of the drying Ranns become encrusted by layers of shimmering salt crystals giving an impression of a frozen Polar sea! The Ranns it bears repeating, most certainly are not deserts of sand and rock like the Thar, the Rub al Khali or the Sahara. That *T. caudata* often moves out on to the dry Ranns is because it feeds on seeds, insects and spiders blown out by the strong surface winds so prevalent in these parts.

Sálim Ali did not come across either of the Jungle Babbler *Turdoides striatus* or the Large Grey Babbler *T. malcolmi* in Kachchh, though both babblers were recorded in Kachchh by earlier European ornithologists. Interestingly, *T. striatus* is common in the Gir and areas south of it, but totally absent across rest of Saurashtra; interestingly an isolated population survives at Wankaner north of Jasdan from where a flock was trapped and released at Hingolgadh two decades ago, the birds have settled down well. Significantly, though, there has been no expansion into surrounding areas. In Gandhinagar, when I moved in, I had both *T. caudatus* and *T. malcolmi* freely patronising the birdtable but there were no *T. striatus*. After my compound became densely foliated followed by a thick leaf litter, a flock of *T. striatus* dropped in and now they and *T. caudatus* share the offerings while *T. malcolmi*, though present outside the compound do not come in! Both the larger babblers are common throughout Gujarat, keeping to their favoured habitats, whenever a flock of one intrudes into the habitat of the other there is a cacophony of babbler calls till the intrusion is vacated.

While on the subject of babblers it may be worth recalling an interesting observation. I had shifted to Gandhinagar in March. To my surprise I found all the *T. malcomi* with dark brown breasts! I had considered collecting a couple of specimens to send to the Bombay Natural History Society, my rather poorly developed scientific temper quickening to the possibility of describing a new subspecies! Fortunately my zeal as a scientist was not motivating enough and I did nothing for a month by which time, the brown breasted babblers had assumed the normal light colouring! The non violent scientist in me was piqued and I began to ask questions: the answer flashed upon me when I realised that the coral trees which were in full bloom at the time of my shift had lost their inflorescences — the brown on the breasts was on account of the dark brown pollen. Next March I confirmed this explanation and further noted that the Blackheaded Mynas also had their breasts smudged. Pollination of these "birdflowers" was done by the pollen brushing off on to the breasts and not the foreheads of the birds! Enough on babblers, let us move on.

iii. Subfamily SYLVINAE : Warblers

Warblers are a confusing group and there is very little qualitative information to add to Sálim Ali's notes of half a century ago. There is, perhaps, considerable data awaiting research in the records of the huge numbers of birds mistnetted in the '60s and 70s. The most significant was the adding of a large warbler — the Thickbilled Warbler *Acrocephalus aedon*; this wetland vegetation bird was overlooked all along for the very similar Indian Great Reed Warbler *A. stentoreus*. *A. aedon* is a winter visitor which, it would appear, is widespread and not uncommon. *A. stentoreus* more vocal though equally a skulker in dense reeds where Sálim Ali found it "fairly common". He makes no notation to the effect that it is a winter visitor. This is what it was believed to be till it was found calling loudly among mangrove thickets of the Gulf of Kachchh, I suspect it nests in the Pirotan mangrove swamp north of Jamnagar, as well as on the major islands of Bhaidar, Nora and Chank at the entrance of the Gulf. The Paddyfield Warbler *A. agricola* was very plentiful in reedbeds during winter but with the desiccation and destruction of reeds across Saurashtra and Kachchh, the status of this Warbler and the Blyth's Reed Warbler *A. dumetorum* need checking. "Curiously," as Sálim Ali notes, "...not met with at all in Kutch, Saurashtra or elsewhere in Gujarat" but if I recollect clearly, many were indeed netted and *A. dumetorum* is a bird more of *Acacia* thickets. Sálim Ali makes no mention of the Moustached Sedge Warbler *A. melanopogon*, again a case no doubt of its being a great skulker during winter. I recall the late Shivrajkumar Khachar mentioning it and I myself seeing what I suspected was this bird on a couple of occasions. The reedbeds are gone and so, presumably with them, this species.

Another skulking reedbed Warbler similar to *A. melanopogon* and perhaps confused with it is the wintering Grasshopper Warbler *Locustella naevia*, which Sálim Ali collected near Cambay and observed on wetlands around Baroda. Perhaps this bird is widespread though "not common or abundant ... usually flushed in likely patches ...tall standing or flattened down grass at the edge of drying-up tanks or in swampy depressions". Sálim Ali failed to meet the Bristled Grass Warbler *Chaetornis striatus* which Capt. A.E. Butler found "not uncommon about Deesa (north Gujarat) in the rains at which season it breeds". Grass, whether wet or dry as in the grass reserves of Kachchh and Saurashtra, is a favoured haunt of the tiny Streaked Fantail Warbler *Cisticola juncidis*. It is a monsoon breeding bird, the little males drawing attention to themselves by their "zigzag chip-chipping" soaring display flight. I found these little birds on the sand islands of Bhayder in the Gulf of Kachchh.

Sharing very similar habitat along the sea coast from Beyt and on to the sand dune grasslands bordering the Ranns in Kachchh is the tiny, but very longtailed Streaked Wren-Warbler *Prinia gracilis*, recorded by Salim Ali in Kachchh, on the "Beyts" in the Little Rann and at the head of the Gulf of Khambhat near the old seaport of that name. I recorded it on each of the grass covered dune islands of Pirotan, Karumbhar, Bhayder and Hanuman Dandi of Beyt along the southern side of the Gulf of Kachchh. Another widespread warbler is the Plain Wren Warbler *P. subflava* which inhabits edges of wetlands, standing millet and grassy verges of fields, as well as young sugarcane. It continues to be a "common, resident". The attractive Ashy Wren-Warbler *P. socialis* appears to be absent in Kachchh. It is very localised in Saurashtra but widespread in Gujarat, preferring better vegetation both along streams, and in farmland and gardens. In Gandhinagar, it is a confiding inmate of my garden.

Two wren-warblers with very specific habitat preferences are the tiny Rufousfronted Wren-Warbler *P. buchanani* and the large Jungle Wren-Warbler *P. sylvatica*. The former is "Resident. Affects dry sparsely scrubbed semidesert country" sharing the habitat of the Redwinged Bush Lark, both birds being common in the preferred habitat across Saurashtra, north Gujarat and Kachchh. *P. sylvatica* appears to prefer taller grass and a heterogenous admixture of shrubs and small trees, and is distributed all over the State. Its present status in Kachchh needs confirmation as does its continued presence in central Saurashtra where considerable damage has been done to protected grasslands. The least demanding in habitat other than perhaps the most arid is the tiny Franklin's Wren-Warbler *P. hodgsonii* which continues to be "Resident. Common and generally distributed" all over the State. This little warbler, like *P. socialis* and the Tailor Bird *Orthotomus sutorius*, stitches leaves of fast growing monsoon herbs, thereby optimally exploiting ephemeral vegetation in the most degraded of habitats. Interestingly, *P. hodgsonii* has a longer tail during the non-breeding period and has the grey upper parts replaced by brown, making for confusion in identity.

The perky Tailor Bird *Orthotomus sutorius* continues to thrive throughout the State and the loud call is heard even in the smallest of gardens in rapidly expanding urban sprawls. Reading through Sálim Ali's paper I was thrilled to learn that under pressure of the absence of broad-leaved plants in Kachchh, "The bird builds a nest of the *Cisticola* type, woven out of vegetable down with a number of narrow leaves sewed to it at the sides for support." This explains the versatility of the little bird; at my bird table, it feeds on *chapati* crumbs and bananas along with the mynas and bulbuls.

The remaining species of warblers belong to three genera, one among them is an autumn passage migrant, the rest are winter visitors. It takes considerable experience to identify the members of this entire group, except for the Orphean Warbler *Sylvia hortensis*, from one another in the field. Though not shy and permitting fairly close observation, their restless movements while hunting insects among thickets of thorn, and among foliage of trees makes it difficult to register the minor differences. Some of the tiny *Phylloscopus* species are difficult to identify even in the hand. Experience goes a long way in recognizing the species as I learnt fairly early when going out with the Delhi Bird Watchers' Club under the guidance of the legendary Horace Alexander to whom Sálim Ali deferred in opinion on the "Little Brown Jobs". Most amateur birdwatchers of the present time are abysmally ignorant where warblers and pipits go, and we may never really get substantial field information. Over the years, I have noticed a very dramatic decline in the number of all the wintering warblers. This, I suspect, is largely due to habitat alteration and degradation. One of the best methods of identifying individual species was by the locale it was seen in — for example the Booted Warbler *Hippolais caligata* was "abundant between September and January" in "babul, Khandi, and similar scrub jungle, *keeping to the canopy*" (italics mine). A continual "harsh *chuck, chuck* or *churr, churr*" draws attention and assists in identification. Sálim Ali indicates the possibility of this warbler being resident, but there is no confirmation to the effect. The Lesser Whitethroat *Sylvia curruca* continually utters a "low *tek, tek, tek* like the clicking of one's tongue against the palate" as this formerly "common, abundant and widely spread winter visitor" restlessly hunts among its preferred babool and kandi groves and hedgerows. Apart from the sound, the distinctive white throat stands out to advantage. *S. curruca* has three subspecies wintering with us; formerly these were considered separate species and we used to spend considerable time deciding whether the bird in sight was *S. curruca*, *S. althaea* or *S. minula*. The Whitethroat *S. communis* is no longer an "abundant" passage migrant following the retreat of the SW Monsoon in September. Kachchh and Saurashtra are on the eastern edge of this bird's outward migration route and the alteration in habitat most certainly has reduced the numbers. Of course, most birdwatchers today tend to go out birdwatching in winter and then too, gloss over the warblers. A very attractive and really quite distinctive wintering bird in tamarisk and *Acacia senegal* thickets is the not common though regular Desert Warbler *S. nana*. Kachchh and the edges of the Little Rann in Saurashtra is where one should go in search of this quietly attractive warbler.

As a group, the several Leaf Warblers are distinctive with their small size, restless movement among foliage and flicking of wings. Identifying the various species of these wintering birds, however, is another matter. I was rather fortunate in that I was introduced to the group early in life in Delhi which, during the 1950s, was a birding capital. One needs to be very committed and regular birder to be able to remember the distinctive calls and identification formulae of one or two wing bars, a bar down the crown, and other colour combinations of greens, browns and yellows. We would be advised to be very cautious like Sálim Ali who was always very concerned not to be wrong! The Brown Leaf Warbler *Phylloscopus collybita* is perhaps the commonest and most widespread, with a distinct preference for babool and waterside shrubs, less so in dry hedgerows where it could be confused with the very similar *Hippolais caligata*, barring the flicking of its wings. The Olivaceous Leaf Warbler *P. griseolus* has a very distinctive habit of operating on boles of trees and rock outcrops instead of among foliage and herein lies its identification character; Hingolgadh and situations like it are this warbler's preferred habitat where, though not common, it continues to be regular. The other Gujarat *Phylloscopii* are the Yellowbrowed Leaf Warbler *P. inornatus* easier to identify by its lisping *"tis yip, tis yip"* call, the Dull

Green Leaf Warbler *P. trochiloides* with a high pitched *"chiwee"*, the Large Crowned Leaf Warbler *P. occipitalis* which is usually overlooked, being silent and partial to taller trees, and the Tytler's Leaf Warbler *P. tytleri*, a bird I have yet to record to my satisfaction. Sálim Ali records it as "not uncommon" in the Dangs. I am sure other Leaf Warblers drop in, especially in better forested locations, but are largely overlooked for the reasons indicated earlier. A serious birdwatcher with an academic bent of mind may well produce a scholarly paper on habitat preferences of our wintering warblers, highlighting the need for qualitative afforestation instead of the present efforts.

iv. Subfamily Turdinae : Thrushes, Robins and Chats

This subfamily has ninety three species on the subcontinent's list, most of which are Himalayan and of Oriental origin. Others are winter migrants from temperate Eurasia with races breeding in the high Himalaya and still others, especially chats, from the deserts of Southwest Asia and Arabia. Only eight are resident or likely to be so in Gujarat; of these, the Indian Robin *Saxicoloides fulicata* continues to be a "common" resident freely associating with human beings, with a penchant for placing its nest in cornices under eves of houses and fuse boxes of lamp posts in Gandhinagar.

The Brown Rock Chat *Cercomela fusca* is endemic to India. It can be overlooked as a female Indian Robin though it never cocks its tail. The hill forts of Kachchh and the rocky outcrops north of Palanpur are this chat's home where it is "not uncommon". It was with great surprise that I saw a bird on the ruined temple of Harshad on the west coast of Saurashtra north of Porbandar. I would not be surprised if this chat is found on the rocks of the Barda Hills near Porbandar. A pair was seen on rocks of a narrow gorge in Panch Mahals north of the Mahi by Pranav Trivedi and identification confirmed by Lalsinhbhai Raol.

The fine voiced magpie Robin *Copsychus saularis* is absent in Kachchh, but is a breeding bird over much of Gujarat and Saurashtra wherever old mature trees survive. In non-breeding season this bird scatters over a wider area, affecting tangled shrubberies and hedgerows where it is joined by the Blackbird *Turdus merulus* which was — atleast till very recently — exceedingly common as a breeding bird at Mt. Abu. Sálim Ali says it is "absent" in Kachchh and he had not come across it in Saurashtra though it was a regular nonbreeding visitor to gardens at Jasdan. The shaded high corridor forests of the Gir and Girnar are eminently suitable for it. Incidentally, *C. saularis* is particularly plentiful in the Gir. The Blackbird's nesting on the higher hills of Gujarat like Jessor in the north, adjacent to Mt. Abu and those of Rajpipla and the Dangs needs to be confirmed. The exact status of the Orangeheaded Ground Thrush *Zoothera citrina* also needs checking; Sálim Ali came across a single bird in South Gujarat but is unsure of the species' status. The Malabar Whistling Thrush *Myophonus horsfieldii* was recorded by him in the south where its present status needs confirmation as does the possibility of its occurring in the Rajpipla hill forests. The importance of regular birdwatching by amateurs cannot be over emphasised and we have a fine example of the record of a very unusual winter visitor, the Dark Thrush *Turdus obscurus* at Porbandar on the western seaboard of Saurashtra. This thrush is a winter migrant to the Oriental Region from Eastern Siberia where in breeds. In India there have been very few observations by earlier birdwatchers. The Porbandar record being the most recent by Lalsinhbhai Raol who in the late sixties and seventies was habituated to go birdwatching to selected locations every weekend. He as was his habit took down careful notes on the spot and not finding the bird in his run of the mill books, went out again the next morning — which tortuitously was a holiday — and found the bird rumaging among litter under dense babool shrubberies as on the previous day. He took further careful notes and sent them onto me and I could immediately identify the species from Stuart Baker's FAUNA. This brings me to another point Sálim Ali always urged, to the point of nagging, birdwatchers, he insisted, must immediately make notes and not leave things to memory — an ommission, I have sadly been indulging in through my own half a century of watching.

The tiny Pied Bushchat *Saxicola caprata* is a resident in open hill country of South Gujarat, though elsewhere it is a winter visitor from north India along with the Stone Chat *S. torquata*, both species being common in fallow cultivation and on the edges of drying jheels in Kachchh, Saurashtra and Gujarat. Numbers appear to have thinned out, no doubt on account of the indiscriminate use of pesticides resorted to in the 1970s. There has been a very perceptible drop in numbers of these formerly "fairly common and abundant" Black Redstart *Phoenicurus ochruros* all over the state in cultivation, along nallas in scrub and dry deciduous forest, and on old monuments. The decline is undoubtedly on account of pesticides, among other deleterious factors like changes in cropping and degradation of vegetation quality.

Both the Blue Rock Thrush *Monticola solitarius* and the Blueheaded Rock Thrush *M. cinclorhynchus* are winter visitors, the former to rocky coasts, prominent hills and large buildings, in use and in ruins, abandoned quarries and the like, while the latter in forest country, principally of south Gujarat though it has been recorded on several occasions at Hingolgadh in central Saurashtra and I am convinced it visits the Jessor hills close to Mt. Abu where there was an early record. It should be looked for in the Girnar and Gir forests.

Sálim Ali has no record of the Blue Chat *Erithacus brunneus*, a bird well known for its supposed nonstop flight from the Himalaya to the Nilgiris and associated high hills of Kerala and further south in Sri Lanka, however I have recorded a female at Hingolgadh after a violent thunderstorm in late September, when interestingly enough Sálim Ali was visiting with us. Undoubtedly, this was a storm tossed migrant blown off its normal epic flight. The Bluethroat *E. svecicus* continues to be a "common, and locally abundant" winter visitor favouring reedbeds and sedges on wet ground, irrigated winter wheat and lucerne and suchlike locations. Though normally seen when flushed, it is not a shy bird and can be watched hopping on the ground at fairly close range when the Redspotted and the Whitespotted races can be made out in the males. In March, prior to emigration, males may be seen on telegraph wires singing vigorously. During September, Kachchh and the northern half of Saurashtra (Hingolgadh inland and the Jamnagar coast) have the attractive Rufous Chat *Erythropygia galactotes* passing through on its way to wintering grounds in Africa. The numbers tend to fluctuate from one autumn to another; it is a very attractive little bird, quite un-chatlike in deportment and worth making a special effort to see.

To conclude this section we are left with the several species of *Oenanthe* chats, all of which are partial to semidesert and desert facies. They are all winter visitors and range from common to uncommon from Kachchh in the northwest towards east and south. The Isabelline Chat *O. isabellina* and the slightly smaller Desert Chat *O. desertii* are fairly plentiful on edges of salt deserts, heavily grazed pastures, dried margins of reservoirs and coastal sand dunes. The Redtailed Chat *O. xanthoprymna* is a bird of desert country around the edges of the Ranns specially with rocky outcrops. There are old records from the base of Mt. Abu and Morvi in Saurashtra. I have seen it near Jasdan and below Hingolgadh. The Pied Chat *O. picata* is inexplicably no longer "very common and abundant in Kutch and the semidesert western portions of N. Gujarat." It was equally abundant in the hill pastures of Saurashtra. The decline was noticed by myself and pointed out to Shivrajkumar Khachar in the Jasdan area some two and a half decades ago; the reasons are puzzling. This chat is polymorphic and has three very distinct colour phases, one all black, one with a white crown and the more plentiful one without a white crown and a white lower breast and abdomen. The last colour phase can be confused with the Hume's chat *O. alboniger* of Baluchistan, and the white crown phase with Pleschanka's Chat *O. pleschanka* and the very similar Hooded Chat *O. monacha*. The former breeds in the arid mountains of NWFP, Gilgit, Ladakh and Lahaul, while the latter is a winter visitor to the Mekran Coast — there are possibilities of these three desert species appearing on the hills of Pachchham, Khadir and Bela south of the Great Rann in particularly severe winters.

Family PARIDAE: Tits

Three species of tit occur in Gujarat, the endemic Whitewinged Black Tit *Parus nuchalis*, the Grey Tit *P. major* and the Yellowcheeked Tit *P. xanthogenys*. *P. nuchalis* needs to be carefully monitored since Kachchh and adjacent rock hills of Balaram and similar rocky outcrops further south are its main habitat, this tit was recorded by Sálim Ali as "fairly common in Kutch but capriciously patchy". The immense alterations in vegetation in Kachchh and northern Gujarat, thanks to unimaginative blanket plantations of *Prosopis chilensis* cannot but have had an adverse effect. *P. major* is patchily distributed in the better wooded parts of Gujarat and in the Girnar and Gir forests in Saurashtra, though it is absent from those areas inhabited by *P. nuchalis* in north Gujarat and curiously absent from most of Saurashtra and the agricultural areas of central Gujarat. Since *P. major* has been recorded near the base of Mt. Abu not far from Balaram, the ecological imperatives of the two species would make a fascinating study. The handsome Yellowcheeked Tit *P. xanthogenys* has a patchy distribution in forested hill country along the eastern edge of the State, the locations recorded by Sálim Ali being Hathidhara near Mt. Abu, the Rajpipla hill forests south of the Narmada and the Dangs further south. The present status in these specific locations calls for investigation.

Family SITTIDAE: Nuthatches and Tree Creepers

The beautiful Velvetfronted Nuthatch *Sitta frontalis* was found to be "fairly common" in moist deciduous forests of south Gujarat, and the Spotted Grey Creeper *Salpornis spilonotos* was "not uncommon" in such ecologically diverse situations as around Deesa on the edge of the Rann in north Gujarat and in the teak forests of Rajpipla! I myself heard a song which I believe was of this species in a babul grove near Ahmedabad. We need current information on both these little birds which presumably are resident in Gujarat. Their continued presence may well confirm the health of the forest ecosystems they inhabit, which may, by and large appear to be badly damaged.

Family MOTACILLIDAE: Pipits and Wagtails

Like the warblers, pipits are a very neglected group of birds. Identifying the different species requires considerable experience and very regular observation. Except for the Paddyfield Pipit *Anthus novaeseelandiae*, all the others are winter visitors. Our resident pipit occurs in cultivation and on grassy verges of jheels over much of the State. Sálim Ali noted it as "a common resident species". I am not sure the position remains the same. The migratory pipits often sharing the same habitat as the resident species should actually make for exciting bird identification and amateur birdwatchers should spend more time unraveling their seemingly confusing identities. The first two are the Indian Tree Pipit *Anthus hodgsoni* and the very similar Tree Pipit *A. trivialis*. Sálim Ali considers the former as "uncommon" and the latter as "rare in Kutch and common and abundant in Gujarat and Saurashtra". The Tawny Pipit *A. campestris* continues to be even now "common and abundant", especially on open pastures and stony plateaux. The Redthroated Pipit *A. cervinus* is not common and this view was held also by Dharmakumarsinhji, though I suspect it is often overlooked. The same may be true of the Vinaceousbreasted Pipit *A. roseatus* and the Water Pipit *A. spinoletta*, specimens of the former were collected by Dharmakumarsinhji, and examined by Sálim Ali and the latter unsatisfactorily identified as such by Sálim Ali. The rather large and dark Brown Rock Pipit *A. similis* is not uncommon as indeed Sálim Ali found it to be in dry, rocky country by preference. There are specific demands by each species and the location of sighting could help field identification immensely, but being migrants and with habitats all heavily disturbed by human activity, birds may turn up anywhere. Even so, qualitative, very patient observation over several years may be most enlightening, specially in understanding how confusingly similar species indeed maintain their specific identity.

On the other hand, wagtails in their full breeding plumage are a delight to watch and easy to identify. Confusion however, is generated at the time of their arrival in September and October, when a large number are juveniles and have yet to don their adult plumage. By March, just before they migrate to the Himalaya and beyond, all the birds are in brilliant nuptial attire and flocks of them on cropped grass beside water or in irrigated plots are a feast for the eyes. Broadly, among the wintering Wagtails we have the Pied or White Wagtail *Motacilla alba* with white underparts, french grey upper parts and varying amounts of black on the crown and breast; the several subspecies of the Yellow Wagtail *M. flava* with yellow underparts and greenish grey upperparts; the two subspecies of Yellowheaded Wagtail *M. citreola* and the Grey Wagtail *M. cinerea* with a light yellow wash, especially on the abdomen and vent and light ashy grey above. *M. cinerea* tends to be a solitary bird, to be looked for beside shady forest streams and along roads in well wooded compounds. It is uniformly distributed in suitable locations throughout the State, though the ideal locations are along the hill streams from Mt. Abu south to the Dangs and the Girnar and Gir forests. Before migrating, the males become lemon yellow on the lower parts, with a black throat. The several subspecies of Yellow Wagtails in full plumage are so distinctive that they were formerly considered separate species. Sálim Ali collected the Greyheaded Yellow Wagtail *M. flava thunbergi*, the Blueheaded Yellow Wagtail *M. f. beema* and the Blackheaded Yellow Wagtail *M.f. melanogriseus* during the surveys, later all the subspecies were trapped in mistnets. Yellow wagtails formerly used to literally swarm over irrigated fields and collect in large roosts in reedbeds along with *M. alba* and swallows, their numbers have sharply declined undoubtedly on account of the heavy, indiscriminate use of pesticides. *M. alba* was a common sight on lawns of palaces and large houses of the elite, and with the break up of properties and lawns being abandoned, this bird is now less frequently seen within urban settings. Pesticides too have reduced their numbers. Of the two subspecies of *M. alba*, Salim Ali mentions only *M. a. dukhuensis* though *M.a. personata* has been seen on several occasions at Jasdan. The Society's mistnetting data may help us to update our subspecific knowledge of both *M. flava* and *M. alba*. Both subspecies of the Yellowheaded Wagtail *M. citreola* occur with us; never swarming as *M. flava* did, they are still fairly common though more in solos among other Wagtails on the grassy verges of irrigation tanks. Like the pipits, the Wagtails show very distinct habitat preferences which need to be studied. Sálim Ali has the following to say about the resident Large Pied Wagtail *M. maderaspatensis* "Resident. Local and uncommon in Kutch and Saurashtra, more generally distributed in Gujarat though nowhere abundant." The position remains the same today though heavy pollution of all water courses in Gujarat and their disiccation in Kachchh and Saurashtra have had adverse effects on numbers.

About the Forest Wagtail *M. indica* Sálim Ali's observations remain true "Winter visitor. Rare. Sporadic solos met with in moist deciduous biotope." His conjecture that it "possibly occurs" in the Gir forest of Junagadh (Saurashtra)" has, to the best of my knowledge, been proved true. To see this unusual wagtail, which wags its tail from side to side, the best bet would be to quietly walk along forest streams of the Rajpipla hills or those of the Dangs. I have yet to add this species to my life list.

Family Dicaedae: Flowerpeckers
Family Nectarinidae: Sunbirds
Family Zosteropidae: White-eyes

Gujarat has two species of flowerpeckers, the Thickbilled Flowerpecker *Dicaeum agile* and the Tickell's Flowerpecker *D. erythrorhynchos*. Both are tiny, very nondescript birds and so are largely overlooked. According to Sálim Ali, flowerpeckers are absent in Kachchh and there is no record of them in Saurashtra. *D. agile*, however, is not uncommon in Saurashtra among large trees, and undoubtedly also intrudes into Kachchh. *D. erythrorynchos* however is indeed restricted to areas south of Vadodara where "as elsewhere, inseparable from clumps of the *Loranthus* plant parasite infesting mango and other trees." Sálim Ali mentions the possibility of a third species, the Plaincoloured Flowerpecker *D. concolor*, occurring in the Dangs. Any takers? All three are tiny and nondescript.

The Purple Sunbird *Nectarinia asiatica* is an exuberant presence throughout Gujarat from flowering *Capparis aphylla* overhanging the saline expanses of the Ranns, sand dune islands in the Gulf of Kachchh overgrown by *Salvadora persica*, to the moist evergreen forests of the Dangs. The Rajpipla forests are the northernmost limits of the Yellowbacked Sunbird *Aethopyga siparaja* which Sálim Ali found "common in the Surat Dangs". It is in the Dangs that a look out needs to be kept for the two Western Ghats sunbirds — the Small Sunbird *Nectarinia minima* and the Loten's Sunbird — *N. lotenia*. Sálim Ali has only "a single unconfirmed sight record" of the Purplerumped Sunbird *N. zeylonica*, though resident birdwatchers of Vadodara and Surat may well come across a good many more. I have always found this otherwise brightly plumaged sunbird quite easy to overlook as it flits atop tall trees and I suspect I have actually been watching this bird casually in the fine foliage trees of Sayaji Baug, of Vadodara.

The White-eye *Zosterops palpebrosa* is common all over Gujarat and Saurashtra among all types of trees. I am sure it is also present in Kachchh where Sálim Ali did not come across it, since it is drawn to *Salvadora* trees in flower and fruit right out on to islands in the Gulf of Kachchh and inhabits mangroves as well. Flocks of white-eyes are very mobile and the bird spreads about over the entire region in the nonbreeding season. Nesting, however, is in more restricted, better wooded parts of the State. We need actual nesting records.

Family Ploceidae: Weaverbirds and Sparrows
Family Fringillidae: Buntings and Finches

The House Sparrow *Passer domesticus* continues to be "ubiquitous" in cultivation and around human habitation, whether in densely populated urban settings or around isolated shelters of shepherds in seeming wilderness. Birds, especially in urban areas, assemble in huge flocks to roost in favoured trees, often drawing a Shikra which benefits by picking off a sparrow from among the melée. Sálim Ali graphically writes about these concourses thus "When shooting down into the thickets, or flying out on alarm the whir of their thousand wings was like surf breaking in the distance." Such huge numbers of seed eaters, it would appear, are an unmitigated disaster to farmers, yet *P. domesticus* , like its ubiquitous cousin the Baya *Ploceus philippinus*, rear their young on green caterpillars and other insects which would wreak incalculable damage on young monsoon crops. Sálim Ali has a very valuable observation which I quote since it bears emphasizing that birds are invaluable pest controllers and there is no need to systematically poison the countryside by spraying insecticides. He writes thus: "In the town of Bhuj the young were fed very largely on a green defoliating caterpillar which was swarming on googar (*Balsamodendron mukul*) and other bushes, denuding them completely of the newly sprouting leaves."

Both the Blackthroated Weaver *P. benghalensis* and the Streaked Weaver *P. manyar* need to be carefully recorded for their nesting. Sálim Ali had not recorded the latter and had collected five of the former in Kheda District south of Ahmedabad. He suggests that the sexes segregate into male and female flocks outside the breeding season which coincides, as it does in case of the Baya Weaver *P. philippinus*, with the southwest monsoon, when insects are at their maximum. In non-breeding plumage the three species of weavers are difficult to tell apart. *P. philippinus* continues to be ubiquitous and nesting colonies are to be seen everywhere. They have taken to nesting, often singly, in suburban gardens!

The Yellowthroated Sparrow *Petronia xanthocollis* is perhaps less "common and abundant" than a couple of decades ago for it is a bird of light jungle interspersed by cultivation. It was found all over the State in Kachchh and Saurashtra, as well as in the better wooded South. Interestingly, this sparrow prefers holes and cracks in trees for nesting in and is less partial to such accommodation available in buildings; habitat degradation and the spread of the very competitive House Sparrow should be seen as reasons for the apparent decline of *P. xanthocollis.*

Among the munias, the pretty Red Munia *Estrilda amadava* is rather locally distributed in Gujarat, affecting reedbeds where it nests. Stray occurrences have been reported from various locations in Saurashtra. There is need for more detailed information. The attractive green Munia *E. formosa* is to be looked for in grass jungles of the eastern hills from near Palanpur in the north to Rajpipla and the Dangs in the south. For this Central Indian species, Gujarat would appear to be on the western edge of its range, we have no authentic records. The Whitethroated Munia *Lonchura malabarica* is the most widespread of the munias, happily occurring in habitats from near desert to cultivation bordering on forest in the South. Its southward spread appears to be in consonance with the habitat degradation in former forest areas and the incursion of grasslands and cultivation. On the other hand, the Whitebacked munia *L. striata* appears to be restricted to the Dangs. The spotted Munia *L. punctulata* is more widespread in Gujarat south of Vadodara, though I have seen them in the Gir forest in Saurashtra.

Our resident buntings are the Striolated Bunting *Emberiza striolata* and the Crested Bunting *Melophus lathami*. The former is locally found in Kachchh, Saurashtra and north Gujarat, very partial to rocky hillocks; at Nir on the edge of the Great Rann, numbers collect to drink at watering places for cattle, along with Little Brown Doves and Redvented Bulbuls. Sálim Ali also makes special mention of this. *M. lathami* is a bird of grass and dry scrub of the type in the Panch Mahal and Rajpipla along degraded riverain country. Gujarat's eastern hill borders appear to be the western limit of this bunting's continental range. The other three common buntings —the Greynecked Bunting *Emberiza buchanani*, Blackheaded Bunting *E. melanocephala* and the Redheaded Bunting *E. brunniceps*— are winter visitors in fairly large numbers, the former favouring drier, open rocky country of Kachchh and Saurashtra, while the latter two assemble in huge flocks in agriculture. Formerly, they were well spread out in monsoon crops of millets and sorghum, but with groundnut becoming the major rainy season crop in Saurashtra these buntings have moved away. Central Gujarat remains the main area for these two buntings, though on passage in autumn and spring they may be plentiful in Kachchh and Saurashtra. Sálim Ali makes no mention of other wintering *Emberiza*, however, I have seen a fine specimen of the Whitecapped Bunting *E. stewarti* near Hingolgadh, while Shivrajkumar and I identified a pair of Little Bunting *E. pusilla* near Jasdan and we mistnetted several Ortolan Buntings *E. hortulana* at Hingolgadh. These last, should be recorded in BNHS's birdbanding database.

Among the Fringillinae, the Common Rosefinch *Carpodacus erythrinus* is a fairly common winter visitor, generally distributed over the entire area with largest concentrations in the agricultural champaign of central Gujarat from Mehsana south to Baroda, where it mixes freely with the Blackheaded Bunting *E. melanocephala*. The scarlet males are surprisingly unobtrusive, and attention is drawn to the birds only when a flock flies up and settles along electric wires crossing fields when their generally dark colouring, thick bills and distinctly forked tails are observed. Birdwatchers in Kachchh, have recently reported sighting the Trumpeter Bullfinch *Carpodacus githagineus* in Kachchh, which brings me to the end of this overview of the birds of the Gujarat region.

CONCLUSION

As I went over Sálim Ali's two part paper published in the early 1950s, I was struck by the man's diligence on the one hand, yet realised how limiting such time-based collection surveys can be. The importance of regular birdwatching through the years and ofcourse meticulous recording of observations cannot be over emphasized, as I realise to my own chagrin. When I look for dates of my own records, I cannot lay my hands on any: I do not have careful notes of the half century of bird watching which got me to know such outstanding ornithologists like General Harold Williams, Horace Alexander, Dharmakumarsinhji, Humayun Abdulali and of course Sálim Ali. If younger birdwatchers today feel I encourage them without hesitation, it is because of my own vivid memories of how much these giants of yesteryear encouraged me, and if at times I dampen youthful excuberances for recording rare sightings, it is because I remember Sálim Ali, cajoling me to be cautious and extremely methodical. I am saddened to find that just when awareness for the environment has grown, amateur birdwatchers are playing a less meaningful role. While birdwatching fiestas like the annual waterfowl censuses and anniversary bird counts are to be welcomed, it is the day to day observations, the simple act of putting out food on bird tables, or hanging birdboxes that are needed to generate a populace-wise concern for the decline in birds as a whole.

I am aghast at how the giants, for all their field expertise, failed to highlight strongly the importance of indigenous vegetation for native birds this perhaps is a pointer to the fact that the tendancy to plant exotics, almost to the exclusion of native species had not been as prevalent then as during the intervening decades. Though Sálim Ali's paper does have an underscoring of ecological imperatives and there is a continual reference to *Prosopis* as a bird tree, irresponsible, or at best ignorant, promoters of *Prosopis chilensis* across the Gujarat countryside may use this as a justification for their actions, claiming for the intrusive alien the highest of biological significance quoting no less an authority than Sálim Ali it must be pointed out that Sálim Ali's *Prosopis* is the fine desert tree *P. spicigera* variously known as "Khijado," "Khijadi," "Sami" or "Khandi," indigenous of the desert tracts of Kachchh, Saurashtra, north and central Gujarat and the desert regions of Marwar in Rajasthan. Significantly Sálim Ali does not mention *P. chilensis* the "Gando Bawal" of Saurashtra and "Hadkayo Bawal" of Kachchh so dear to the heart of professional foresters. Today this tree dominates extensive areas and the ecological fallouts have yet to be evaluated. Conservation of birds, whether it be through improving grassland management for the Great Indian Bustard and the Lesser Florican, the care of wetlands for safeguarding nesting sites for the Sarus Crane, the cleaning up of sewage and industrial wastes from rivers to rehabilitate the Pied Kingfisher or the protection of tall timber forests to help the Black Woodpecker to survive, the needs of the birds are the needs of the people and herein lies the necessity of shedding any apologetic attitudes towards our concern for birds. Any action taken will merely enrich the human environment.

TWENTIETH CENTURY CHANGES IN THE AVIFAUNA OF PAKISTAN

T.J. Roberts[1]

Invited by a former colleague of Dr. Sálim Ali and eminent member of our Society to contribute such an article, I do so with some hesitation. Any attempt to comment on the changes in population levels or status of birds during the past ninety years or so, must remain largely on a speculative and anecdotal level, rather than through a scientific approach. It must be limited by the paucity of baseline data, and further weakened by the lack of any recent population studies in Pakistan, with the single exception of water fowl counts during midwinter, conducted on most of the major wetlands (Scott 1989). Nevertheless, whether we consider ourselves as 'just nature lovers', or seriously concerned about conservation, there is an urgent need to recognise biodiversity 'hot spots', and changes in bird populations as valuable ecological indicators, both of the more vulnerable ecosystems as well as areas where man's exploitation of natural resources is causing undue long term damage. We are all aware of the growing detrimental effect upon former relatively stable undisturbed habitats, whether it be reclamation of former desert through massive new irrigation projects, the effects of more intensive agricultural practices with more complete jungle clearance and greatly increased use of agro-chemicals, or deforestation in the catchment areas of the north, to meet ever growing fuel wood needs. The Indus river and its surrounding plains are the very backbone and nerve centre of Pakistan's economy, and responsible for 90% of her food production. Miracles have been achieved as has also been the case in India, but we have yet to evaluate the long term costs. The whole hydrological system of this mighty river and its tributaries has been profoundly changed. Many of the five rivers of the Punjab and the lower reaches of the Indus itself are practically dry during the midwinter months due to offtake from thirteen irrigation barrages, and one of the biggest and most complex irrigation systems in the world. Even after the monsoon rains, many former areas of seasonal inundation no longer receive sufficient flood water to remain even as swamps. As a result, vast tracts of former riverain forest have dried out or been cut down, and salinity levels in the Indus mouth and surrounding Arabian sea have been significantly raised, with detrimental effects upon an important fish spawning and nursery area.

All these twentieth century changes have had a varying effect on wild birds, and before considering such changes a few statistical pointers will reinforce the above generalities. Human population pressure, with its ever growing demands for exploitation of natural resources, is known to be the direct cause of the disappearance of many of our larger and more spectacular birds. When the author first came out to India in 1946, I recall the anxiety expressed in the local press in 1947 with the great influx of human refugees, when the population of West Pakistan, as it was then called, was estimated to have swollen to 45 million. Latest estimates by Washington based research groups, Worldwatch and the World Bank, put the present population at not less than 121 million. A total increase of 2.66% in a period which demographers would categorise as spanning only two generations (25 years being taken as one generation). Turning to the agricultural revolution, comparable figures are difficult to obtain, but the Sind Gazetteer (Sorley, Edit. 1968), for example, recorded the total area under cultivation in that province in the years 1900-1901 as 27,130 hectares. By 1956 (the latest figures published) this had risen to 59,797 hectares. The total national area under cultivation increased from 14.69 million hectares in 1947-48 to 20.73 million hectares in 1989-90 (Environment & Urban Affairs Div., Govt. Pakistan, 1992). Similarly, the total area under irrigated cultivation in 1950-51 was 9.25 million hectares which had risen to 15.68 million hectares by 1989-90 (Environment & Urban

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[1] "Cae Gors", Rhoscefnhir, Anglesey, Gwaynedd, LL75 8YU, U.K.

Affairs Div., op.cit.). In 1947, canals were reported as taking up 65 million acre feet of water from the rivers. This rose to 95 million acre feet by 1976 (Pakistan Fact Sheet. Water. 1989). There are conflicting figures given for the total area in Pakistan under natural and plantation forest, with a low of only 3.6% of her total area (Jalal *et al.* 1977), up to 4.3 million hectares (Biswas 1987). Fuelwood needs are estimated at 16.6 million (cu. m.) of timber annually, whilst the Pakistan Forest Institute estimated the total annual increment or growth of wood at 11.3 million cu. m., which means that annual growth only provides 62% of annual offtake from the forests. Sadly, 90% of this timber is used for fuel rather than for construction.

I have derived the basis for evaluating changes in bird fauna from written observations from Baluchistan (Meinertzhagen 1920), from Sind (Ticehurst 1922-24), from Punjab (Whistler, for Jhang area 1922, and Rawalpindi district 1930); from the Murree Hills (Whistler 1930 and Magrath 1909), and for the Punjab Salt Range (Waite 1948). All these writers, it must be remembered, were summarising observations over earlier periods than the publication dates reveal. Added to these published commentaries on the status of certain species are my own observations from 1947 up to 1984 when I retired to Britain, with frequent shorter visits to Pakistan in every subsequent year until 1995.

Any bird species population has three essential requirements for maintenance levels. Firstly, it requires sufficient natural shelter to hide or escape from predators and to be able to forage or hunt. Secondly, there must be adequate amounts of suitable food available. Thirdly, freedom from physical disturbance or harassment by predators in order to breed. In my experience, nearly every instance where a population is declining can be attributed to some extent to loss of suitable habitat. If sport hunters or hunters who persecute a species for commercial gain can be considered as merely another element in the predator/ prey relationship, then there is evidence that this becomes the major factor only when a species is considered on cultural grounds as a highly desirable target, but this must be coupled with a relatively small existing population (which usually makes the target all the more desirable). The following survey will show how important this factor has been on larger, more spectacular, species. Wherever detailed ecological studies have been conducted upon a wide range of bird species in the Subcontinent, shortage of food has never been recorded as a restraint on population levels.

A more or less random survey follows, categorising birds in the older conventional taxonomic order (Voous 1977, not Sibley and Monroe 1990).

Procellariformes, Pelecaniformes - Petrels, Shearwaters, Boobies, Cormorants and Pelicans: Despite clear indications of over fishing in Pakistan's coastal waters, there is no evidence of decline in sea bird levels along the Arabian sea coast. This is because birds hunt visually, whether by diving or under water swimming, and this is a more efficient method of catching single marine prey species than the large scale netting by fishermen, even when using sophisticated sonar detection aids and excessively long mono-filament nets. There is evidence that Boobies (*Sula* spp.) in the Indian Ocean as a whole have declined seriously in numbers, and this is thought to be due to predation by human egg harvesting in remote breeding islands outside our territory.

Anseriformes - Ducks and Geese: Ticehurst (1922-24) reported that "without doubt the Gadwall was the commonest duck" as a winter visitor to Sind. Similarly, Whistler (1922) reported that it was by far the commonest duck in Jhang district in the winter. Waite (1948) writing his observations in the 1930s wrote that Mallard 'were to be met with in small numbers', and Ticehurst (op.cit.) wrote that the Mallard 'was to be met with in variable numbers, being strangely absent in many suitable lakes'. This author's own observations, corroborated by recent wildfowl counts conducted under the auspices of the IWRB, confirm that the Gadwall is today comparatively rare all over the Indus basin as a winter visitor, whereas the Mallard is today by far the most abundant migrant species. The Cotton Teal (*Nettapus coromandelianus*) was considered 'rather local and rare' (Ticehurst, op.cit.). Waite (op.cit.) and Whistler (1930) do not record the Cotton Teal at all as having occurred in northern Punjab, whereas I have found it resident in the seepage zone around the Islam Headworks on the Indus in the Salt Range. It is also widespread and resident in Sind today, though only occurring in small numbers outside of the southern part of that province. Evidently this Oriental species has spread westwards, perhaps favoured by creation of well vegetated seepage zones upstream of every major irrigation barrage.

Greylag geese and Barheaded geese have declined dramatically in numbers. Ticehurst, who lived in Sind during the World War I years, described both species as 'common enough, with huge flocks to be met with on the larger Sind lakes'. Today, wildfowl censuses of every major wetland in Pakistan (Scott 1989) usually reveal a midwinter national total of barely 20 to 30 Greylags, mostly with only three or four individuals at one place. Barheaded geese have undoubtedly suffered from disturbance by domestic stock grazing in their northern breeding lakes, with increased exploitation of such upland steppes by grazing co-operatives in Tibet. Recent wildfowl censuses have only revealed small numbers wintering on the Indus river by Taunsa barrage in south central Punjab, and below Guddu barrage in northern Sind. Perhaps these depressing census figures will emphasise the great value and importance of Keoladeo National Park (Bharatpur) as a winter refuge for these two species.

Galliformes - Pheasants, Francolins, and Quail: In the 1930s Whistler reported that the Cheer pheasant (*Catreus wallichi*) still survived in the Galis of Hazara district, and it was hunted by Ainsworth Harrison (pers. comm. and photos) in the Margalla hills (now a National Park adjacent to Islamabad) during the 1950s. Recent surveys in several widely separated areas (Mirza 1977 and 1978) have indicated that this pheasant is probably extinct in the wild in Pakistan, though there has been a captive bred re-introduction project. When I acquired a summer cottage in Dunga Gali in 1960 in the Galis, a local villager, hoping to please me, offered to take me shooting Monal (*Lophophorus impejanus*) on Mukshpuri mountain nearby and indeed they did survive there in small numbers. Today they are extinct throughout the Murree hill range. Whistler also described the White Crested Kalij (*Lophura leucomelana hamiltonii*) as fairly common in the Murree foothills. By the late 1960s it was very rare in any of the foothill regions and indeed extinct from some of its former haunts (Mirza, WWF Pakistan Surveys, 1977). Happily the creation of Islamabad as a new capital and the relocation of settlers from the Margalla hills, which was later declared as a National Park, has in this one locality enabled the Kalij to make a remarkable recovery, and there are good numbers surviving within this small area. Down in the plains, the Black Francolin (*Francolinus francolinus*) has become a rare bird, confined to a few pockets where there are man-made irrigated plantations or in the few remaining riverain forest tracts. When the author first came out to the Subcontinent in 1946, this species literally swarmed over large tracts of lower Sind where we had farming interests, and it was relatively common even in cultivated areas of the Punjab, whereas today it is totally absent from most cultivated tracts. The more desert adaptable Grey Francolin (*F. pondicerianus*) has fortunately fared much better.

Ciconiiformes - Storks, Ibises, Bitterns and Egrets: Whereas the White Stork (*Ciconia ciconia*) in Asia is everywhere much rarer than at the beginning of this century, such indigenous species as the Painted Stork (*Mycteria leucocephala*) and the Blacknecked Stork (*Ephippiorhynchus asiaticus*) have become virtually extinct in Pakistan. Whistler, writing about Jhang in the Punjab, described the Blacknecked Stork as reasonably common, and in the 1960s there was always a pair or two to be seen (author obs.) on Lal Sohanran Lake in Bahawalpur district, whence they have long since disappeared. Trapping of young Painted Storks, plus hunting for food of adults by local fishermen in Sind, has wiped out the breeding population of this species which has become extremely rare. Ticehurst in Sind reported the Black Ibis (*Pseudibis papillosa*) as very common, the White Ibis (*Threskiornis melanocephalus*) as fairly common, the Glossy Ibis

(*Plegadis falcinellus*) as very common, and the Openbill Stork (*Anastomus oscitans*) as common, though he considered the Blacknecked Stork as 'not common'. Today, the Black Ibis is a rare summer visitor to border areas of lower Sind only, the breeding White Ibises in the Indus delta have been all but wiped out by animal trappers for the zoo trade, as was the fate of the Painted Stork. There is no evidence that Openbilled Stork have bred in Pakistan since the turn of the century, though small numbers have been reported (Koning and Walmsley 1973) wintering on remote wetlands on the India-Pakistan border in the Rann of Kutch. By contrast Lesser, Medium and Great White Egrets have all become more plentiful, judging by Ticehurst's writings, and these species seem to be more tolerant of human proximity and also able to exploit smaller areas of inundation. Certainly Ticehurst described the Great White Egret (*Egretta alba*) as rare in Sind, whereas today it is common to see scores feeding in close proximity on all the larger lakes.

Charadriformes - Snipe, waders, plovers, gulls and terns: Regimental Game books provide a valuable record of shooting bags in the early part of this century, and the Kurram valley is an important migration route over the Himalaya for snipe and cranes. Shooting bags of Common Snipe (*Gallinago gallinago*) from this area record up to 200 birds from as few as five guns in one afternoon in the 1930s, whilst today it would be difficult to flush more than a few dozen in a full day's walk through rice stubbles in this valley. The Sociable Plover (*Chettusia gregaria*) was described by Ticehurst as a fairly common winter visitor in Sind, and by Whistler in Jhang as an abundant winter visitor. Undoubtedly, changes in agricultural practices in its former central Asian breeding grounds have pushed this species to a very limited breeding area of wormwood (*Artemisia* sp.) steppe in northern Kazakhstan (Knystautas 1987), so that it is one of Pakistan's rarest winter visitors. In 34 years I only obtained one record from the Thar desert. The Great Stone Plover (*Esacus recurvirostris*) was described by Whistler in Jhang as a common summer breeder along the Chenab river, and in Sind Ticehurst wrote that it occurred all down the Indus. Due to decreased flow of water in the rivers enabling seasonal cultivation right in the riverain beds and as far as main channel banks, there is very little undisturbed breeding habitat for this species which has become comparatively rare. The same has happened to the numbers of fresh water terns, with colonies of Gullbilled Terns (*Gelochelidon nilotica*) which both Waite and Whistler recorded on the Jhelum and Chenab rivers in summer having virtually disappeared, and very few Blackbellied Terns (*Sterna acuticauda*) or Indian River Terns (*S. aurantia*) are able to breed successfully due to disturbance of their nesting grounds. Gullbilled Terns, however, do not appear to have decreased in numbers around Pakistan's coastal areas. I have no evidence of any species of Laridae having declined noticeably.

Accipitriformes - Hawks, eagles, falcons, and vultures: The most dramatic decline within this order is amongst the falcons which have become the target of every local bird trapper because of the high prices paid by those 'oil wealthy' countries whose passion is falconry. The species which have declined most dramatically are the Saker (*Falco cherrug*), and Peregrine (*F. peregrinus*), with surprisingly the Laggar (*F. jugger*) and the Red Headed Merlin (*F. chicquera*), since these smaller falcons are often used, after being trapped, to lure their larger predatory cousins. Snares, set with feral pigeons as decoys, trap all these species indiscriminately and even less valuable species are not released back into the wild. Only the Kestrel (*F. tinnunculus*) seems common, if not increasing in numbers, being present all over the Indus plains in winter and breeding throughout the northern areas right up to the border with China. Two species of vulture appear to have declined also. Ticehurst described the Egyptian Vulture (*Neophron percnopterus*) as excessively common in all the larger towns of Sind. Today, though not rare, it is by no means common and totally absent from many of the larger towns. Both Waite in the Salt Range, and Whistler in Jhang described the Black or King Vulture (*Sarcogyps calvus*) as a breeding resident, though in small numbers, and Ticehurst recorded it as fairly common throughout

Sind. In 34 years I only came across stray individuals both in Sind and Punjab on less than six occasions, and believe that a resident population no longer exists in Pakistan, though these birds may wander widely in winter and some may still breed in Tharparkar border areas.

Gruiformes - Cranes, bustards, and rails: Sálim Ali in the first volume of his handbook series (1968) and Stuart Baker in the FAUNA OF INDIA series (1929) quote Phillips describing a migrating flock of Demoiselle cranes (*Anthropoides virgo*) in 1929 in Punjab as comprising a dense flock of 50 m wide and 38 km long, totalling hundreds of thousands. Today, few skeins of more than 50 to 80 birds are ever seen together on migration anywhere throughout Pakistan. Indeed most of the population wintering in the Rann of Kutch in India migrates to the west through Baluchistan, not crossing Punjab at all. Intolerant of disturbance from humans and requiring vast wilderness areas for safe nesting, all the crane species have declined dramatically, especially those wintering in the Subcontinent. The story of the Houbara Bustard (*Chlamydotis undulata*) is even sadder due to the high level of hunting which continues every year by visiting Arab dignitaries at the invitation of the Pakistan Government. Though hunted by the ancient art of falconry, modern sophisticated methods of detection and vast financial resources employed in scouring their main spring migration routes through Baluchistan have taken a heavy toll on the population. Due to restrictions placed on the Provincial Wildlife Departments on any attempts at monitoring the hunting camps and conducting population surveys, there is no concrete evidence of surviving numbers, but their population is reported by Russian experts (Alekseev 1980) to have declined alarmingly from their main breeding grounds in the Kuzil Kum desert. Another problem affecting the Common Crane (*Grus grus*), which migrates through the Kurram valley, is the increasing fashion amongst the Frontier tribes to snare them with skilful throwing of weighted 'bolero' cords, using captive birds staked out as decoys. The NWFP Govt. has enacted legislation to both limit and regulate such hunting and the International Crane Foundation has helped with a vigorous campaign of education about their declining numbers, but the people of that region have always been proud of their independence and show a disdain for too much Government regulation.

Pteroclidiformes - Sandgrouse: In the 1950s there were still many small desert tracts in the Punjab around Vehari, Jhang and Lodhran where I recall sandgrouse were common. All these tracts have now been brought under cultivation, largely through the sinking of tubewells in areas which could not be commanded by canal irrigation. Except for small numbers in parts of the Thal and the Salt Range, no sandgrouse occur now in the Punjab. In Sind some of their traditional watering places where they congregated in thousands, according to Ticehurst's accounts, are deserted today because of constant disturbance and use by domestic animal flocks. As a generalisation, sandgrouse — like the desert itself in Pakistan — have both retreated further into the border areas.

Coraciiformes - Rollers, kingfishers and hornbills: The Grey Hornbill (*Tockus birostris*) was not listed by Whistler as occurring around Jhang, though Currie (1916) wrote that it was relatively uncommon around Lahore, but since his day due to increased tree plantation following canal development, it has spread gradually eastwards and southwards into Punjab, from its original confines around the Lahore and the foothill zone. During my 28 years residence at Khanewal in south Punjab, I only began to see stray hornbill visitors from the late 1980s, and they breed from Sialkot down to Renala Khurd. There do not appear to be any significant changes in the population of Pakistan's 4 kingfisher species, nor rollers, and indeed rural telephone lines, seepage from borrow pits following irrigation, and increased area under plough are all factors favouring food and hunting by these families.

Psittaciformes - Long tail parakeets: In Whistler's day, the Plum-headed Parakeet (*Psittacula cyanocephala*) was believed to be a rare winter visitor, but today it is not uncommon as a breeding resident in the Margalla and Murree foothills. Perhaps this restricted zone is more thoroughly watched by ornithologists since the creation of Islamabad as the nearby capital. Rose-ringed Parakeets (*P. krameri*) are considered pests in Pakistan, helped no doubt by the great increase in citrus orchard plantations, and growing of such oilseed crops as sunflower (Roberts 1991).

Piciformes - Woodpeckers and barbets: Again Whistler considered the Bluethroated Barbet (*Megalaima asiatica*) as a rare visitor to the Murree foothills. Today, its calls can often be heard within the city limits of Islamabad and it is a breeding resident up to 1800 m in the Murree hills. By contrast, some of the lower altitude woodpeckers, dependent upon deciduous tree species, have virtually disappeared from the lower hill ranges. I regularly encountered *Picoides macei* in the foothills and *Dendrocopus hyperythrus* in Kao forest in the Galis during the 1960s, but have not been able to confirm sightings by these species by anyone in the last few decades. Local villagers selectively lop deciduous trees in spring for cattle and buffalo forage, maintaining traditional rights which were only sustainable when the human population was much smaller, and this is clearly converting many of these forests into mainly coniferous stands. Without being able to give any explanation, I must state that the Grey headed Woodpecker (*Picus canus*) was relatively common in both Whistler's (1930) and Magrath's (1909) time in the Murree hills. Today it appears to be very rare or has perhaps entirely disappeared from its former haunts.

Passeriformes - Warblers, chats, wheatears, redstarts and finches, etc: To prevent this account from becoming tediously long, I will select only a few random but interesting examples from among this highly varied and species - abundant order.

Focusing first on the Murree hills which were so well documented at the turn of the century, birds not recorded or described as comparatively scarce, such as the Rustycheeked Scimitar Babbler (*Pomatorhinus erythrogenys*), the Blackchinned Babbler (*Stachyris pyrrhops*) and Bluethroated Flycatcher (*Muscicapa rubeculoides*), all seem to be well distributed in the foothill zone or their limited range has been more closely surveyed. All these species appear to survive and indeed flourish within a limited altitudinal zone. By contrast the Yellowcheeked Tit (*Parus xanthogenys*), quite common around Murree as a breeding bird (and with a good series of specimens thence in Museum collection) during Magrath's and Whistler's day, appears to be extinct within Pakistan except as a rare winter visitor (only one published record by Mallalieu 1988) during the last thirty years. Another species apparently extinct for Pakistan is the Whitethroated Laughing thrush (*Garrulax albogularis*). In the 1960s there was a resident band of this gregarious species in Kao forest in the Galis, and at the turn of the century it extended eastwards to Murree (Cock and Marshall 1873). There have been no sightings of this noisy and conspicuous babbler since my records in the 1960s. Some of the higher altitude species, which from all early records were always rare in the western part of their range just extending into Pakistan, are today still surviving in small numbers, as documented by recent ornithological surveys (WPA Annual reports) by teams of expert young ornithologists funded to carry out Western Tragopan surveys. Examples are the Black-browed Flycatcher Warbler (*Seicercus burkii*), the Green Shrike-babbler (*Pteruthius xanthochloris*) and the Whitethroated Tit (*Aegithalos niveogularis*).

Turning to the threatened habitats in the plains, the indigenous species of the riverain tract have had varying fortunes. The Sind Jungle Sparrow (*Passer pyrrhonotus*), rare in Ticehurst's day along the lower Indus and virtually absent from the Punjab, has adapted well to tree-lined major canals, as indeed has the Yellow-bellied Wren Warbler (*Prinia flaviventris*), exploiting seepage areas. Both are common and apparently spreading. But Jerdon's Babbler (*Chrysomma altirostris*), probably one of the Subcontinent's rarest endemics, remains confined to a few isolated pockets, and appears to be suffering from inter-specific competition with its close relative, the Yellow-eyed Babbler (*C. sinensis*). The Whitetailed Bushchat (*Saxicola leucura*) though never as rare as the former, appears to be dwindling because of the shrinkage of its habitat, *Saccharum* grass thickets along the major river banks. Major irrigation schemes have increased both road and canal side tree plantation, which has favoured species more dependent on arboreal foraging. The Redvented Bulbul (*Pycnonotus cafer*) has spread and increased everywhere, driving out the less aggressive Whitecheeked Bulbul (*P. leucogenys*). This applies equally to the hill species (Oriental Bird Club checklist) or sub-species, *P. leucogenys leucogenys*, which now competes with the Redvented up to 1800 m.

These changes are borne out by accounts of their former status by Whistler, Waite and Ticehurst. Species which benefit from man's activities or food can be divided into two ecological categories — commensal such as *Passer domesticus, Acridotheres tristis*, and *Corvus splendens*, and synanthropic such as *Ploceus philippinus* and *P. manyar*. The latter two weavers have undoubtedly increased as a result of more widespread rice cultivation. In remote rural villages, the House Sparrow has become a major pest of ripening cereal crops (Roberts 1992).

What are the lessons or conclusions, if any, which can be drawn from the above review?

We do not want our descendants to live in a world populated only by Mynas, House Sparrows and House Crows, and we have already lost forever some of the ornithological spectacles such as mass migrations or huge gregarious nesting colonies, which earlier writers thrilled to relate. The pressures for growing more food and exploiting our forest resources will increase inevitably in the future and in Pakistan one can expect riverain tracts, seasonal wetlands, and even desert to be under threat. Perhaps the only safeguard is to persuade our political leaders to value such preserved areas or wildlife sanctuaries more than they have done recently, to give such areas greater protection and to try to establish peripheral buffer zones, and help rural communities to gain real benefit from ecotourism. Policies which are already being advocated and successfully put into practice in other countries, are thankfully being tried in several pilot projects in Pakistan. No matter how discouraging the signs, it is surely the duty of all of us BNHS supporters to help create more responsible attitudes and awareness of the sometimes hidden value of such remnant wilderness areas wherever they may occur.

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NEW BIRD RECORDS IN SRI LANKA AND SOME CONNECTED MATTERS

Thilo W. Hoffmann[1]

Introduction

I am very happy to be able to contribute this paper to the Sálim Ali Centenary issue of the JBNHS. I had corresponded with Dr. Sálim Ali over a period of years and met him on several occasions, notably during the BNHS Centenary celebrations in Bombay and the 50th Anniversary Seminar of the Periyar Tiger Reserve in 1985. I used to address him as Dr. Ali or Dr. Sálim Ali, with the emphasis on the "A", in contrast to "Salimalee" (emphasis on last syllable) as then pronounced by many Indians. On one occasion at Periyar, he said to a group of students and admirers who surrounded him: "Listen how Mr. Hoffmann, a Swiss from Sri Lanka, pronounces my name. This is the proper way". I invited him to Sri Lanka but he declined, saying that he could not yet forget the hostile and humiliating treatment meted out to him and Dillon Ripley on their last visit to the island. On that occasion in the mid-1970s the two eminent ornithologists were virtually chased out of Sri Lanka due to inept handling by the US Embassy of their scientific expedition which included collecting, and the chauvinist zeal of a few Lankan conservationists. The Ceylon Bird Club had not been informed of the visit, was indeed unaware of it, and thus unable to help. Sálim Ali never returned to Sri Lanka, undoubtedly a setback for the scientific study of the island's birds.

Nearly 10 years ago, I prepared an update on Sri Lankan Birds (to the end of 1986) and notes on changes in status and distribution compared with Ripley's SYNOPSIS (1982) and Ali and Ripley's HANDBOOK (1968 - 1974); the paper was published in the *Journal* 1986 (1) : 7 - 16. Strangely, there were a number of inexplicable printing errors, e.g. the word vagrant was replaced by migrant in several instances. This was followed by another paper in the same JBNHS [88 (3) : 381 - 383] giving additional details of the 16 accepted sight records which were included in the first contribution. The present paper continues the process up to the end of 1995 in respect of new species and races discovered in the interim.

The Ceylon Bird Club (CBC) which was founded in January 1944, has a unique collection of data on Sri Lankan birds in the form of its monthly Bird Club Notes (CBCN). These notes were extensively used by Ali and Ripley in their works mentioned above. I have been the Honorary Editor of the CBCN since 1970 to date. Ten years ago, the CBC appointed a Rarities Committee which scrutinized and assessed all doubtful records at that time, and since then reviews and judges carefully and objectively all claims which come to its notice. As pointed out earlier (Hoffmann 1991) it would be unreasonable and unrealistic not to accept good sight records in a country where the collection of specimens is now practically impossible; stragglers and vagrants form the majority of new records wherefore serious bird-watchers would have to permanently carry a gun ! Acceptance of well documented sight records is thus in keeping with reality and the trends of the time, but requires very careful observation and note-taking in the field, as well as subsequent scrutiny of all relevant data. To some extent it also is a matter of trust, and controversies cannot be excluded. All of the 22 new records listed in this paper are sight records. For taxonomic reasons specimens will always be required but not for mere recording. Selective collecting by responsible ornithologists cannot be objected to or replaced by other methods such as mist netting (which may in fact be more stressful and damaging to bird populations).

The number of new species and races recorded in recent years in Sri Lanka is quite impressive.

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During the first half of the century this number was almost static, then increased very slowly at long intervals, but since the 1980s, new records average over two per year. Practically all pertain to migrants, of course. Henry (1955) describes 403 species and subspecies, Phillips (1978) lists 427 and Wijesinghe (1994) 463 (plus 14 doubtful). Three more have since been accepted, bringing the total number of forms to 466 at the end of 1995. The recent spate may partly be due to changes in migrating patterns and of environmental factors in neighbouring India, but are mainly the result of wider interest in birds, with more bird-watchers in Sri Lanka and the frequent presence in the country of foreign bird-watching groups and individuals. The groups are usually led by very experienced bird specialists and reputed ornithologists from abroad who guarantee intensive bird-watching of a high calibre. The few local specialist guides greatly profit from such tours and become our most reliable recorders.

LITERATURE

Bird-watchers in Sri Lanka often find it difficult to procure appropriate literature. During the last 40 years G. M. Henry's splendidly written and illustrated Guide to the Birds of Ceylon (1955) has been the only comprehensive source of information but has often been unavailable. The book is again out of print but a completely revised and updated edition will come out in 1997. This classic together with W. W. A. Phillips' *Annotated Checklist of the Birds of Ceylon* (1978) and D.P. Wijesinghe's *Checklist of the Birds of Sri Lanka* (1994) forms the basis of all current knowledge of Sri Lankan birds. W. Vincent Legge's fine *History of the Birds of Ceylon* (1880) has long been out of print, and even the four volume reprint (1983) is neither affordable nor really useful to the modern field ornithologist. Long out of print have been the more popular works by W.E. Wait (1925), Cicely Lushington (1949) and the four small volumes by W.W.A. Phillips (1949 - 1961). Ali and Ripley's HANDBOOK depends mostly on Henry and Phillips' Checklist (with Wait and Legge) for information about Sri Lanka (Ceylon), Ripley's SYNOPSIS on Phillips' Checklist.

NEW RECORDS 1986 - 1995

The following list of new species recorded and accepted in Sri Lanka from 1986 - 1995 relies on D. P. Wijesinghe (1994) in regard to nomenclature. Numbers in brackets are those used in the HANDBOOK and in the SYNOPSIS; birds not listed in either are marked thus (-).

1. Barau's Petrel, *Pterodroma baraui* (-)
   First sighted in 1991 (CBCN May 1993 : 48, 49).
   A rare though possibly regular visitor to Sri Lankan coastal waters.
2. Bulwer's Petrel, *Bulweria bulwerii* (13b)
   Seen 1994 off Colombo (CBCN April 1995 : 32).
3. Audubon's Shearwater, *Puffinus lherminieri* (11)
   First sight record in 1982 and another in 1994 (CBCN July 1994 : 86).
4. Chinese Pond Heron, *Ardeola bacchus* (43)
   First seen and photographed in unmistakable breeding plumage, April 1995 near Tissamaharama (CBCN April 1995 : 33 and May 1995: 40).
5. Lesser Kestrel, *Falco naumanni* (221)
   First seen 1995 at Palatupana (Yala) (CBCN April 1995 : 35), possibly overlooked.
6. Small Button Quail, *Turnix sylvatica* (313)
   One sight record from Yala National Park 1978 (CBCN February 1978 : 7), possibly escapee (thus not mentioned in Hoffmann, 1989).
7. Oriental Plover, *Charadrius veredus* (377)
   Sight record 1994 south-east coast (CBCN January 1994: 7).
   The HANDBOOK and Ripley treat the Oriental Plover as a subspecies (*veredus*) of the Sand Plover, *Charadrius asiaticus*.
8. Nordmann's Greenshank, *Tringa guttifer* (399)
   One 1991 sight record from Hevativu, south

of Palavi (Puttalam), in need of confirmation (*Loris* 1992 : 195, 196).

9. Sooty Gull, *Larus hemprichii* (449)
First sight record January 1993 at Mutwal (Colombo) (CBCN January 1993 : 16 - 17), and 2 birds seen at Chilaw, also in January 1993.

10. Yellow-legged Gull *Larus cachinnans* (450, 451)
There is much confusion in the world literature about the taxonomy of the two large gulls, *Larus fuscus* and *Larus argentatus*, and their numerous geographical races. Individuals of *L. cachinnans* (subspecies : *L.c. cachinnans* and *L.c. mongolicus*), formerly treated as a subspecies of *L. argentatus*, occur in winter along the N-W coast of Sri Lanka, sometimes amongst flocks of *Larus fuscus heuglini*. As the colour of the legs is not a reliable diagnostic feature, a better name would be White-headed Gull, because even in winter the overall appearance of the head is white. *L.f. heuglini* is nowadays increasingly treated as a full species, *Larus heuglini*, Heuglin's Gull.

11. Black-naped Tern, *Sterna sumatrana* (468, 469)
Sight record 1994 some miles off western coast (CBCN April 1995 : 32). Subspecies unknown.

12. Black Tern, *Chlidonias niger* (459a)
Three recent sight records 1992, 1993 (Loris 1992 : 204 - 205) and 1995 (CBCN April 1995 : 38). The HANDBOOK mentions only one old sight record in respect of the entire Indian Sub-continent. In the meantime the Black Tern has been repeatedly noted and ringed at Point Calimere (JBNHS 1994 : 317).

13. Black Noddy, *Anous minutus* (-)
A specimen misidentified as the Lesser Noddy in 1978 (*Loris* 1993 : 44 - 48). Occasional visitor to coasts mainly during S-W Monsoon.

14. European Bee-eater, *Merops apiaster* (746)
First seen in 1993 at Yala (CBCN February 1993 : 23) and subsequently every winter. Rare so far in the south-east of the island but likely to become regular winter visitor.

15. Dusky Crag Martin, *Ptyonoprogne concolor* (914)
First seen 1993 near Colombo (CBCN January 1993 : 14).

16. Eye-browed Thrush, *Turdus obscurus* (1762)
Seen at Nuwara Eliya January to March 1994 (CBCN June 1994 : 73 - 75).

17. Lanceolated Warbler, *Locustella locustella* (1544)
Only one sight record (CBCN December 1991: 72), but may be overlooked.

18. Common Grasshopper Warbler, *Locustella naevia* (1545)
First noted 1993 near Colombo, and annually thereafter (CBCN December 1993 : 107).

19. Grey-headed Mynah, *Sturnus malabaricus* (988)
Flock seen at Anuradhapura 1984 to 1986 (CBCN January 1984:1). A straggler from S-W India, possibly breeding resident (juveniles in flock 1986). Subspecies not known.

NEW SUBSPECIES RECORDED AND ACCEPTED DURING THE SAME PERIOD :

20. Large Crested Tern, *Sterna bergii thalassina* (478)
This smallest, palest race was observed during the early months of 1990 at Colombo (CBCN March 1990 : 25a and *Loris* 1991 : 26).

21. Tytler's Swallow, *Hirundo rustica tytleri* (918)
First seen 1989 and annually thereafter in small numbers (CBCN December 1989 : 71).

22. White Wagtail, *Motacilla alba leucopsis* (1888)
First seen 1995 at Kalametiya (CBCN April 1995 : 32).

THE STATUS OF THE RED FACED MALKOHA

A note regarding the status of the Red-faced Malkoha *Phaenicophaeus pyrrhocephalus*, as a Sri

Lankan endemic may not be out of place here. I cite from the HANDBOOK, Vol. 3 (2nd edition 1981), p. 238: "Resident in Ceylon and South India; rare and local. Was long regarded as peculiar to the island, and reports of its occurrence (and breeding) in Travancore by J. Stewart (in Baker, 1932 -1934) were discredited. However, since then the species has been reliably observed at the foot of High Wavy Mountains in the adjoining Tamil Nadu District of Madurai (C. H. Biddulph, 1956, JBNHS 53 : 697 - 8) therefore previous doubts probably unjustified".

Ripley in his SYNOPSIS (1982) simply states : "Resident Southern Kerala, Southern Travancore (JBNHS 53 : 697 - 8) and Sri Lanka".

A critical look at Biddulph's belated note (1956) on an observation by him in 1931 shows, however, that previous doubts remain more than justified. Paras 5, 6 and 7 read as follows :

"It remained on the tree for a sufficient period of time for me to observe it closely and I made the most of the opportunity, as it was the first occasion on which I had seen a live bird of this species in its natural habitat.

It changed its position on the tree while I watched and made its harsh call three or four times. This call or note has been correctly described by Legge and it was its loud call which first attracted my attention.

The crimson cheek patches were unmistakable and very prominent. I noted its approximate size and shape, colouration, shape of beak and length of the tail in relation to the body".

This is all Biddulph writes about the appearance and habits of the bird he saw, a meagre description which would not pass scrutiny in any rarities committee today. The only specific characteristic he mentiones is "the crimson cheek patches". The crimson-red face of this Malkoha can certainly not be described as "cheek patches". According to W.V. Legge (1878 - 80) the crimson area covers the "whole face as far back as the ears passing over the eye and across the base of the upper mandible".

The HANDBOOK (1981) says : "Its most diagnostic features are the bare red face and heavy apple-green bill".

Thus, whilst Biddulph's description of the face of the bird he saw does not tally with that of the Red-faced Malkoha, the rest is so cursory as to be meaningless.

Biddulph is also wrong with regard to the call of the Red-faced Malkoha. He describes it as harsh and loud. All authorities are agreed that it is soft and low, though not often heard, as the bird is usually silent. W.V. Legge, who in the last century had extensive experience of the Red-faced Malkoha which was then plentiful in Sri Lanka says :

"As a rule it is a silent bird, the only note with which I am acquainted being a rather low monosyllable like call like kaa, which it utters when flying about".[1]

Henry (1955) states :

"Owing to the short, rounded wings, its flight is feeble, slow and direct and, if it has any distance to cover, it commonly prefers to hop from branch to branch until it reaches the top of a tree, and then to flutter and volplane from that vantage-point; in flight, the wings produce a musical hum. It is usually silent, but I have heard it utter short, single-note, yelping whistles; a note like kok - imitated by a sucking action of the tongue; and a low, petulant-sounding krâ".

Henry's rendering of the calls is cited in the HANDBOOK.

Current observers familiar with the Red-faced Malkoha characterize the call as a soft, low "krrr".

Thus the only two significant features which Biddulph mentions in his paper (red cheek patches and call) cannot be accepted as belonging to the Red-faced Malkoha. He has failed to note other typical features such as the heavy apple-green bill, the long, broad graduated tail, the white lower breast, belly and vent, all of which are easily seen, if a good view is had of the bird; even the white flecks on the black nape and crown should have been visible through binoculars at 10 - 13 m distance. If Biddulph did not have visual aids, his identification becomes even more doubtful. The musical hum produced by the wings in flight (Henry) is also noteworthy, as is the mode of movement and flight (Henry).

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[1] Legge was familiar with the bird to the extent of having eaten it; he says the flesh "is tender and not unpleasantly flavoured".

It is astonishing that Biddulph's sketchy note about an observation he made 25 years earlier and his confident identification should have been so uncritically accepted not only in India but also by some in Sri Lanka (only after the HANDBOOK had become available there; Biddulph's paper had apparently escaped notice till then).

About 65 years have passed since Biddulph sat on a machan at the foot of the High Wavy Mountains in the Madurai District of Tamil Nadu and thought he heard and saw a Red-faced Malkoha. To my knowledge, no further records of this species from India have been forthcoming, although in the meantime interest in Indian birds has grown like in Sri Lanka, with hundreds if not thousands of birdwatchers and ornithologists, both Indian and foreign, visiting the relevant forests (where still in existence). It would be a tempting goal to confirm the presence of the Red-faced Malkoha there. But the likelihood that C. H. Biddulph's opinion about the existence "in the favourable localities" of Southern Kerala and Tamil Nadu of the Red-faced Malkoha would be confirmed or authenticated appears most remote.

In the last century the Red-faced Malkoha was present in forests all over the Low-country (except in the northern Dry Zone) and common in the eastern and south-eastern jungle and foothills of Sri Lanka. Today it is confined to the few remaining Wet Zone rain forests such as Sinharaja, Dellawa, Kitulgala. Isolated populations exist in the Dry Zone in dense forests mainly along rivers, e.g. in Wasgomuwa National Park, along the Heen Ganga, Kumbukkan Oya, Menik Ganga and at Lahugala.

It has always been the position of the Ceylon Bird Club that the Red-faced Malkoha must remain a Sri Lankan endemic as long as indisputable evidence about its existence in Southern Kerala is lacking, notably a specimen, of course. Thus the latest authoritative Checklist (Wijesinghe 1994) retains the Red-faced Malkoha as an endemic of Sri Lanka, together with the other 20 species recognised in the HANDBOOK and the SYNOPSIS, and also the following five clearly distinct forms, making now a total of 26 :

The Ceylon Grey Hornbill
Ocyceros gingalensis
The Chestnut-backed Owlet
Glaucidium castanonotum
The Ceylon Small Barbet
Megalaima rubricapilla
The Black-capped Bulbul
Pycnonotus melanicterus
The Ceylon Hill Munia
Lonchura kelaarti

CONSERVATION IN SRI LANKA

The protection and conservation of birds and their habitats receives little attention in Sri Lanka, though on paper all birds, except 6 species considered to be pests, are strictly protected and cannot be killed or taken anywhere in the island. Good habitat protection could be achieved through the Fauna and Flora Protection Ordinance under which an impressive number of National Parks and Sanctuaries has been declared over the years. However, the implementation and enforcement of this and other conservation laws leaves much to be desired. Shooting, trapping and other destruction of birds is unchecked since the late 1950's and the degradation and even elimination of bird habitats continues. Though a few sanctuaries have been specifically created for birds, bird habitat protection is purely incidental in the larger national parks. Sanctuaries in general are neglected and unprotected. Vast tracts of valuable habitats have been lost in recent years not only to felling and clearing but to aquaculture farms which proliferate without control in wetlands along the coasts. Some hope for improvement may lie in the Dutch funded and managed Wetland Conservation Project (WCP), which so far, however, has merely gathered data and made recommendations which remain unimplemented. The highly important wet zone forests which harbour most of our endemics have dwindled to almost negligible proportions, except for the Sinharaja forest, now a World Heritage Site and well protected by the Forest Department. But despite lip service by decision makers and fairly widespread public awareness, the outlook for practical conservation in general, of wildlife and birds in particular, is bleak, as both the Government and the Administration lack the will to act. Unenforced laws are worse than no laws, inviting general contempt. In the matter of conservation there is no coordination between Government agencies; an example is the dry Hambantota area where close to and in the Bundala National Park, Sri Lanka's only Ramsar Site, a massive international oil refinery and power plant, a wind-power farm, salt-based industries and a 1000 acre prawn farm are being planned!

Because of neglect some important specific bird Sanctuaries have suffered severe degradation, for instance the small Galways Land Sanctuary at Nuwara Eliya, the Tangamalai Sanctuary above Haputale and the Kalametiya wetland Sanctuary, also the new Bundala National Park. The most important of all, the Peak Wilderness Sanctuary, with the greatest number of endemic forms, has never received the attention it deserves; we have repeatedly proposed that it should be enlarged to include the lower elevations near Kitulgala from 70 m a. s. l. upward (to over 2200 m) and be joined to the Horton Plains National Park. But even in National Parks, habitat protection is very unsatisfactory. All conservation areas north of a line from Puttalam in the west to Valaichchenai in the east and further south along the east coast are abandoned and suffer actual and grave depredation due to military activities and exploitation, notably Wilpattu, Sri Lanka's formerly most attractive National Park, as well as the Yala East National Park. The presence in the country (Colombo !) of handfuls of foreign experts, NGOs, International organisations and even Government Agencies, all trying hard to influence policies, has not helped. On the contrary, it has alienated and displaced local NGOs and the much vaunted "people's" participation does not even extend to these any more. In a strange alliance of self-interest and convenience with local bureaucrats, it is mainly these foreigners who have successfully argued against effective law enforcement, the easy way out for all concerned. The mandatory EIAs, of great importance in the conservation of habitats, have degenerated to a farce with mushrooming consultancy firms depending solely on the developers for the jobs and their profits. The outlook remains indeed bleak.

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THE RECENT DISTRIBUTION OF ENDEMIC AND DISJUNCT BIRDS IN KERALA STATE: PRELIMINARY RESULTS OF AN ONGOING SURVEY

Anthony J. Gaston[1] and V.J. Zacharias[2]

(*With fifteen maps*)

Introduction

The Western Ghats of South India support many species of endemic birds. In addition, the avifauna includes many species of "disjuncts", populations that are isolated from other conspecifics elsewhere in India; usually in the Eastern Ghats or in the Himalayas. Disjunct species are of special interest because they may represent relict outliers of formerly continuous populations interconnected during the Pleistocene (Ali 1949, 1969). All of the species involved are resident. The Western Ghats are considered an internationally important area for avian species diversity and support 14 species of birds considered to be "near-threatened" globally (Collar *et al.* 1994).

Much of the natural forest remaining in the southern Western Ghats is located in the State of Kerala, where surveys were carried out in 1933-35 by Dr. Sálim Ali (1969). Since 1973, we have been carrying out surveys of birds in the state to assess their recent status and the effects of changes in land-use. Our primary goal has been to assess the current distribution of rare, endemic and disjunct species to provide a background for prioritizing conservation action. Although our surveys are not yet complete, we present some preliminary results, concentrating on trends and distribution patterns that can be unambiguously determined on the basis of results to date.

Natural forests of the Western Ghats in Kerala range from dry deciduous to moist evergreen (Champion and Seth 1968). The highest forests consist of characteristic evergreen associations known as "*sholas*", often bordered by dense thickets of *Strobilanthes* shrubs. The summits of the ranges are mainly grassland maintained by periodic burning, probably an ancient landscape feature.

All of the forests of Kerala have been much degraded by human activities in recent decades, with forests changing from moist evergreen towards deciduous as they are opened up. As a result of recent encroachments by agriculturists and the opening up of forests through widespread timber felling, few forest blocks are now unmixed. Probably all areas include patches of both evergreen and moist deciduous forest. In addition, large areas of high altitude grasslands have been taken over for eucalyptus plantations. Some of these plantations coexist with natural grasses, creating semi-wooded grasslands. Pure natural ecosystems, untouched by felling, grazing or planting, are relatively rare, even within protected areas.

Methods

Surveys were carried out by either or both the authors, sometimes in company with others, in 20 forest areas of Kerala. All species seen or heard were recorded and numbers of less common species were noted. Each survey consisted of a visit of minimum three days duration, covering as large a range of forest types as we could find in the area. We also visited plantations and areas of reafforestation, where these were adjacent to natural forests. However, we did not visit large blocks of plantations. Some areas have been surveyed repeatedly over several years, especially the Thekkady area. Results from Wynaad have already been published (Zacharias and Gaston 1993).

Our plan calls for surveys in all seasons (winter, December-January; hot season, February-May; monsoon, June-September; and post-monsoon, October-November), but this has not been achieved

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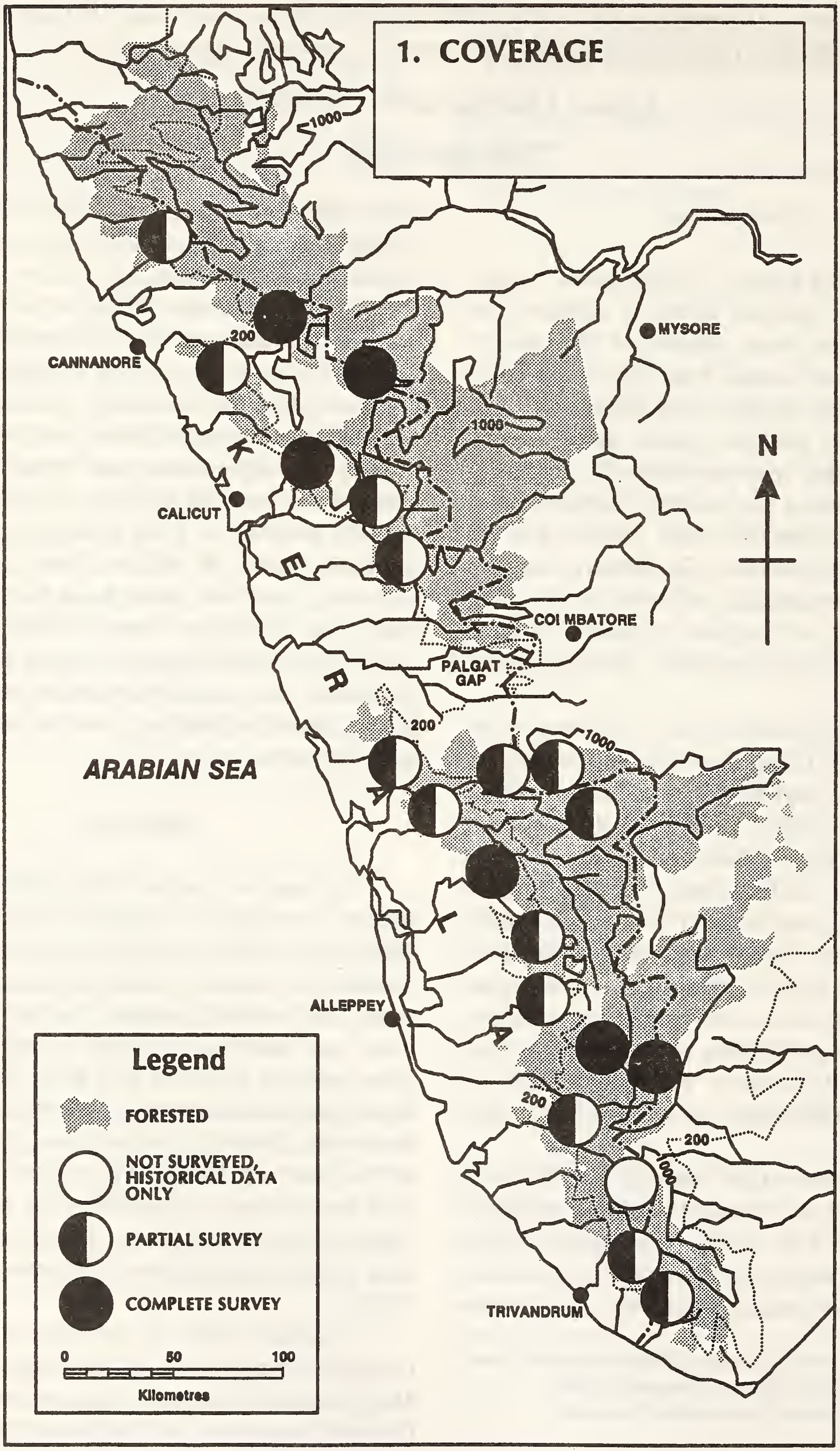

1. COVERAGE
1000
200
MYSORE
CANNANORE
CALICUT
N
COI MBATORE
PALGAT GAP
K
E
R
A
L
A
ARABIAN SEA
ALLEPPEY
TRIVANDRUM
Legend
FORESTED
NOT SURVEYED, HISTORICAL DATA ONLY
PARTIAL SURVEY
COMPLETE SURVEY
0
50
100
Kilometres

for all areas. Map 1 shows the amount of cover achieved by our surveys to date. Complete cover means that visits have been carried out in all seasons. Numerical abundance is estimated on the following scale: abundant, seen in double figures daily; common, seen daily; uncommon, seen on more than 30% of days, but not daily; rare, seen on less than 30% of days. Altitudes are classified as low (<500 m), middle (500-1000 m) or high (>1000 m). Historical data is taken from the literature. Additional forest areas will be surveyed over the next two years, to give more complete coverage.

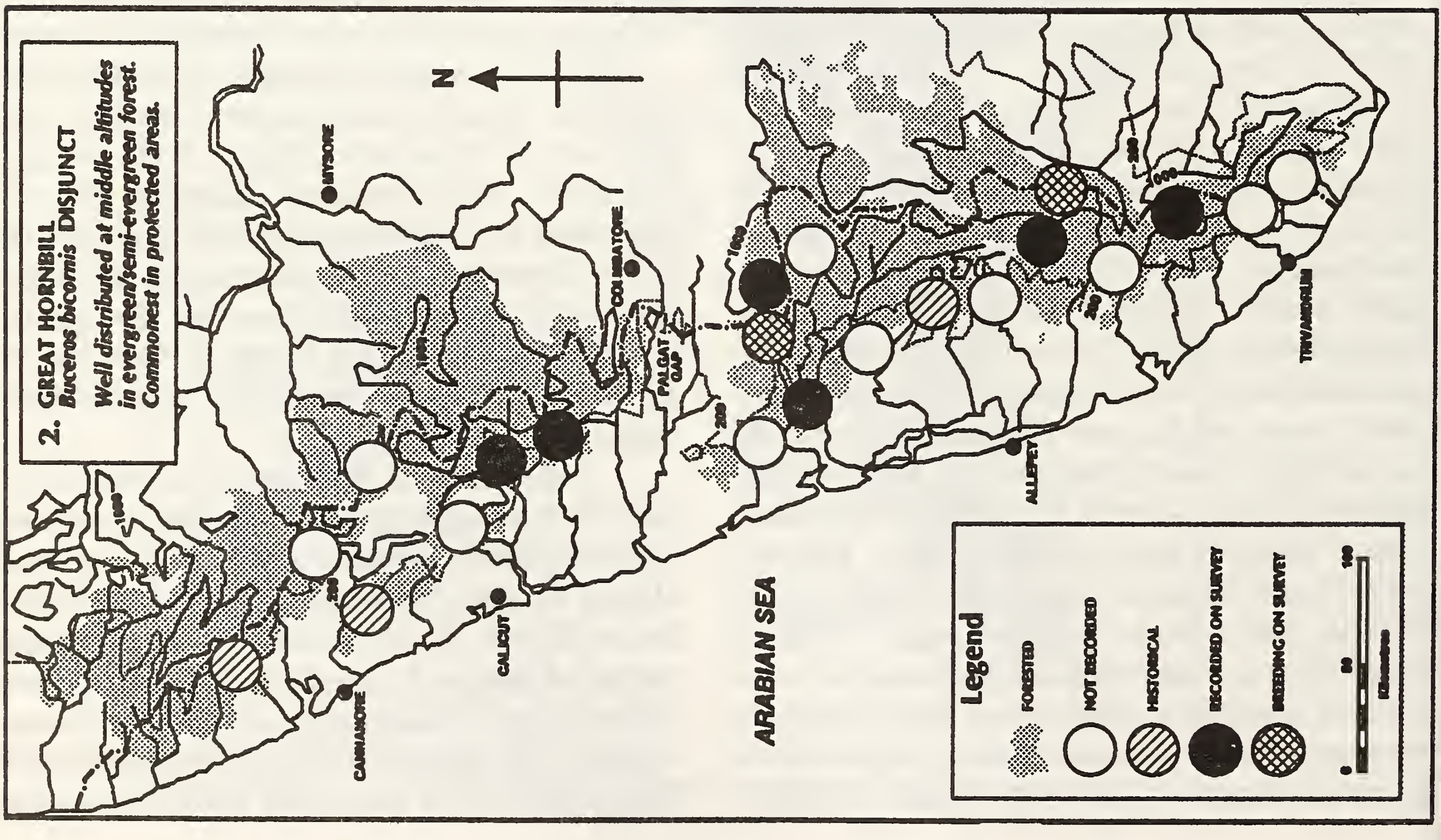
DISTRIBUTIONS

Sample distribution maps are given for 14 species (maps 2-15), comprising one hornbill, one roller, one parakeet, one nightjar, one pigeon, two raptors, and 7 passerines. The most widespread species on our surveys was the Bluewinged or Malabar Parakeet *Psittacula columboides,* recorded at every locality visited. The least was the Ceylon Frogmouth *Batrachostomus moniliger,* recorded in only three areas.

Disjunct species: The species considered disjunct, based on the ranges given by Ali and Ripley (1987) are listed in Appendix 1. We found many to be widespread (seen at more than 50% of localities) and common, especially at low altitudes (Large Brownthroated Spinetail Swift *Chaetura gigantea,* Indian Goldenbacked Threetoed Woodpecker *Dinopium javanense,* Pigmy Woodpecker *Picoides nanus,* Malabar Trogon *Harpactes fasciatus,* Fairy Bluebird *Irena puella*). Some of these species have accommodated to forest fragmentation by occupying small forest patches and plantations. However, disjunct raptors and nightjars were generally patchily distributed (Black-crested Baza *Aviceda leuphotes,* map 7; Jerdon's Baza *Aviceda jerdoni,* Rufous-bellied Eagle *Hieraeetus kienerii,* map 8; Great Eared Nightjar *Eurostopodus macrotis,* map 5; Ceylon Frogmouth) and may be more dependent on large areas of continuous forest. Great Eared Nightjars were not recorded in two areas where they had been previously reported. The Lesser Coucal *Centropus toulou,* reported by Ali as "not uncommon", is now uncommon, with a patchy distribution. The Broadbilled Roller *Eurystomus orientalis* was found only in moist deciduous forest and in only three areas on our surveys. Numbers seen in all areas were small (single figures). As a hole-nester, it may be affected by the removal of old trees. The disjunct species occurring exclusively at high altitudes, Smallbilled Mountain Thrush *Zoothera dauma* and Eurasian Blackbird *Turdus merula,* were uncommon and both were found in only a few localities. These species may have originated from migrant visitors, rather than dispersing from the Himalayas through continuous habitat.

Endemics: A high proportion of these (8/19 spp.) were found only or predominantly at middle and high altitudes (compared to 3/21 disjuncts). High altitude species include those confined to grasslands (Broad-tailed Grass Warbler *Schoenicola platyura,* map 12; Nilgiri Pipit *Anthus nilghiriensis,* map 15), and to sholas (Whitebellied Shortwing *Brachypteryx major albiventris,* map 10; Black-and-orange Flycatcher *Muscicapa nigrorufa,* map 11; Nilgiri Flycatcher *Eumyias albicaudata*; White-breasted Laughing Thrush *Garrulax jerdoni,* map 14). Although found at only a few localities (all recorded at <50% of localities), probably because of their restricted altitude range, several species were common or abundant (Nilgiri Pipit, Nilgiri Flycatcher, White-breasted Laughing Thrush). Grasslands and sholas have probably been affected less by disturbance and degradation than the forests found at lower altitudes. However, the species involved are all confined to the southern part of the Western Ghats and hence have very restricted ranges.

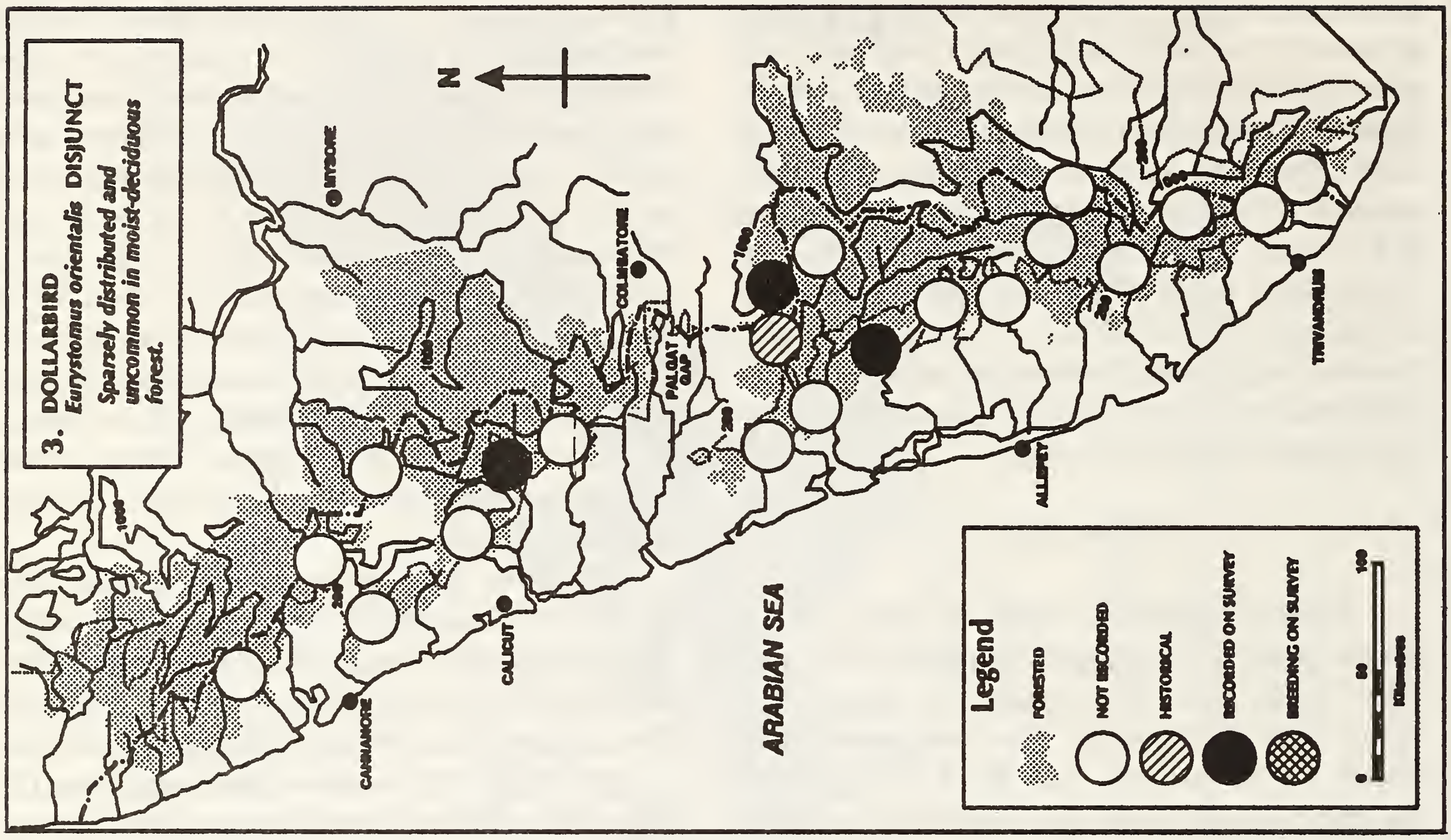
Some endemic species have adapted to plantations and agricultural landscapes (Crimson-fronted Barbet *Megalaima rubricapilla,* Bluewinged Malabar Parakeet, Yellowbrowed Bulbul *Iole indica,* Rufous Babbler *Turdoides subrufus,* Small Sunbird *Nectarinia minima,* Rufous-bellied Munia *Lonchura kelaarti*) and consequently all are common or abundant. Species most affected by habitat alteration are probably the low and middle altitude forest birds



2. GREAT HORNBILL
Buceros bicornis DISJUNCT

Well distributed at middle altitudes in evergreen/semi-evergreen forest. Commonest in protected areas.

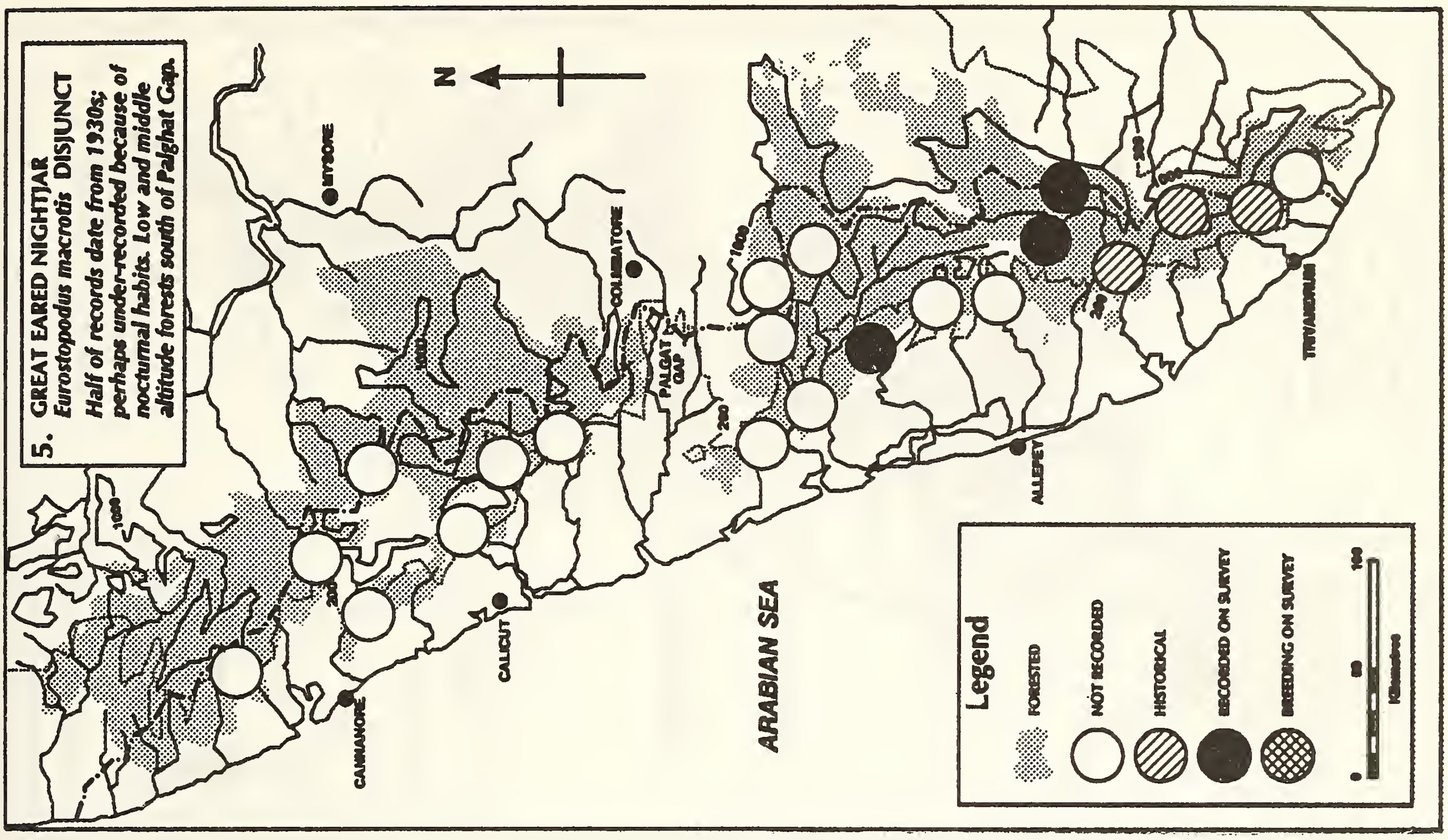
N
MYSORE
COIMBATORE
PALGAT GAP
CANNANORE
CALICUT
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
200
Legend
FORESTED
NOT RECORDED
HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
100
Kilometres



3. DOLLARBIRD
Eurystomus orientalis DISJUNCT

Sparsely distributed and uncommon in moist-deciduous forest.

N
MYSORE
COIMBATORE
PALGAT GAP
CANNANORE
CALICUT
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
200
Legend
FORESTED
NOT RECORDED
HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
100
Kilometres



5. GREAT EARED NIGHTJAR
Eurostopodus macrotis DISJUNCT

Half of records date from 1930s; perhaps under-recorded because of nocturnal habits. Low and middle altitude forests south of Palghat Gap.

N
MYSORE
COIMBATORE
PALGHAT GAP
CANNANORE
CALICUT
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
200
Legend
FORESTED
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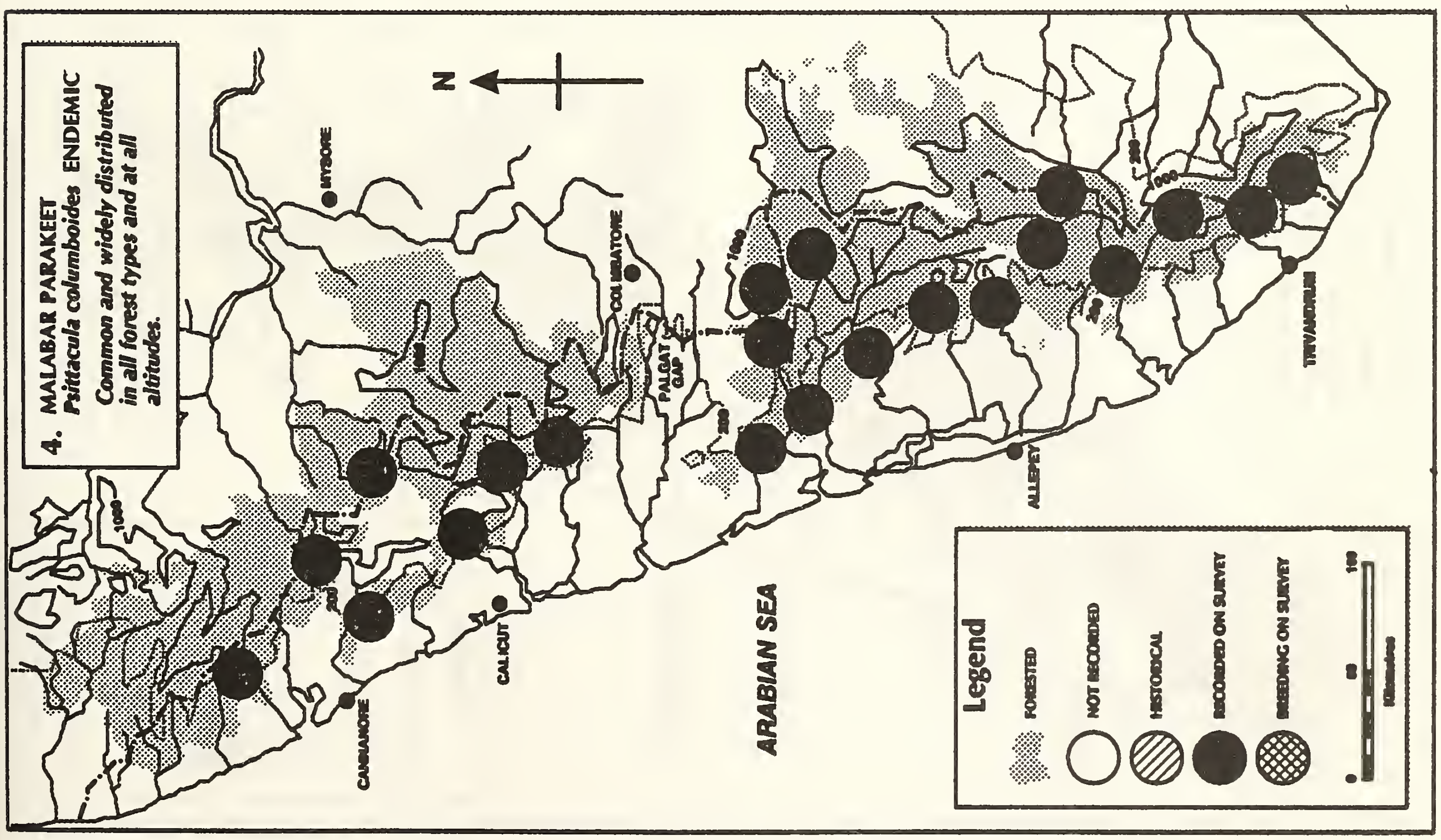
HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
100
Kilometres



4. MALABAR PARAKEET
Psittacula columboides ENDEMIC

Common and widely distributed in all forest types and at all altitudes.

N
MYSORE
COIMBATORE
PALGHAT GAP
CANNANORE
CALICUT
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
200
Legend
FORESTED
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HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
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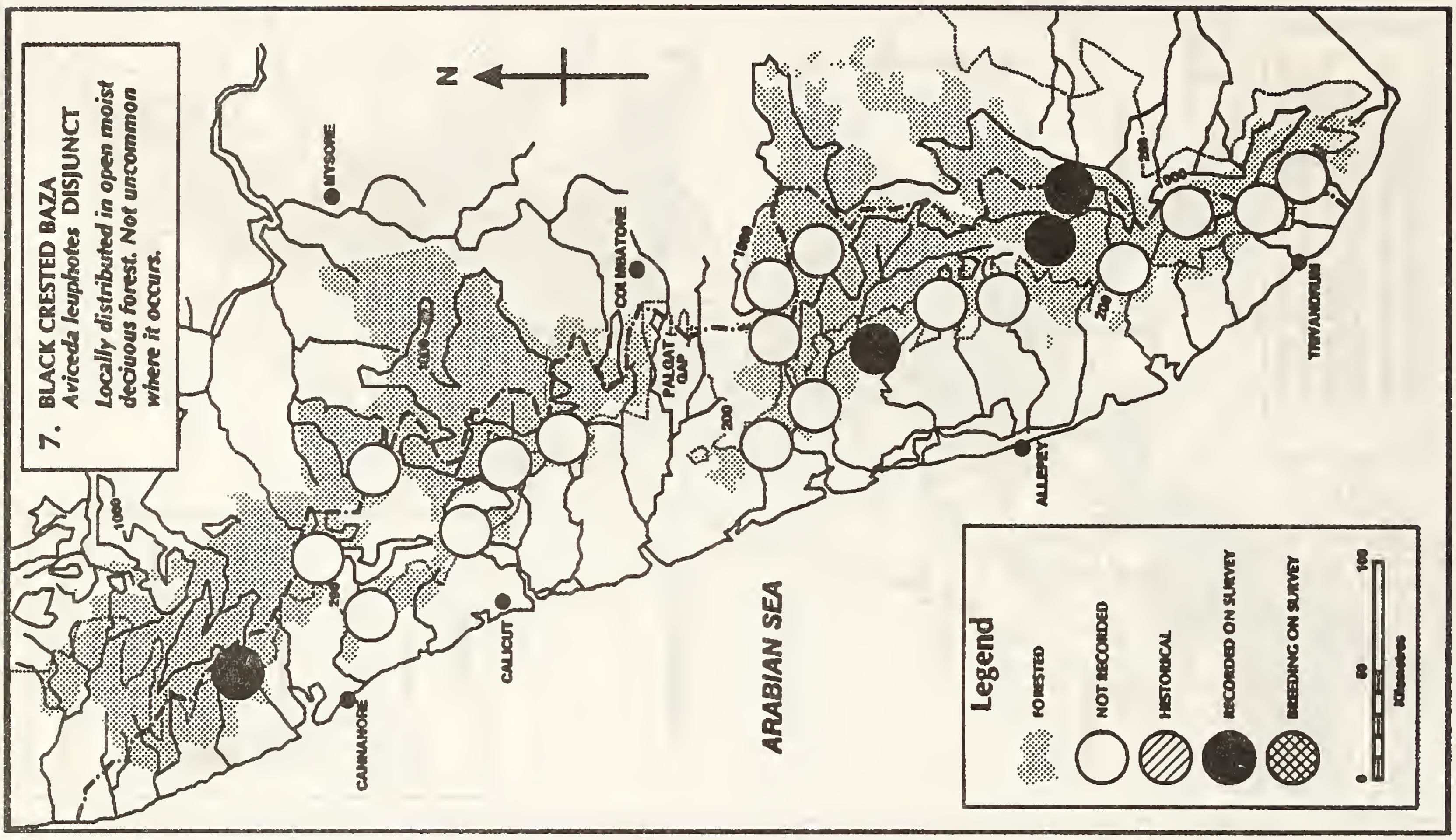
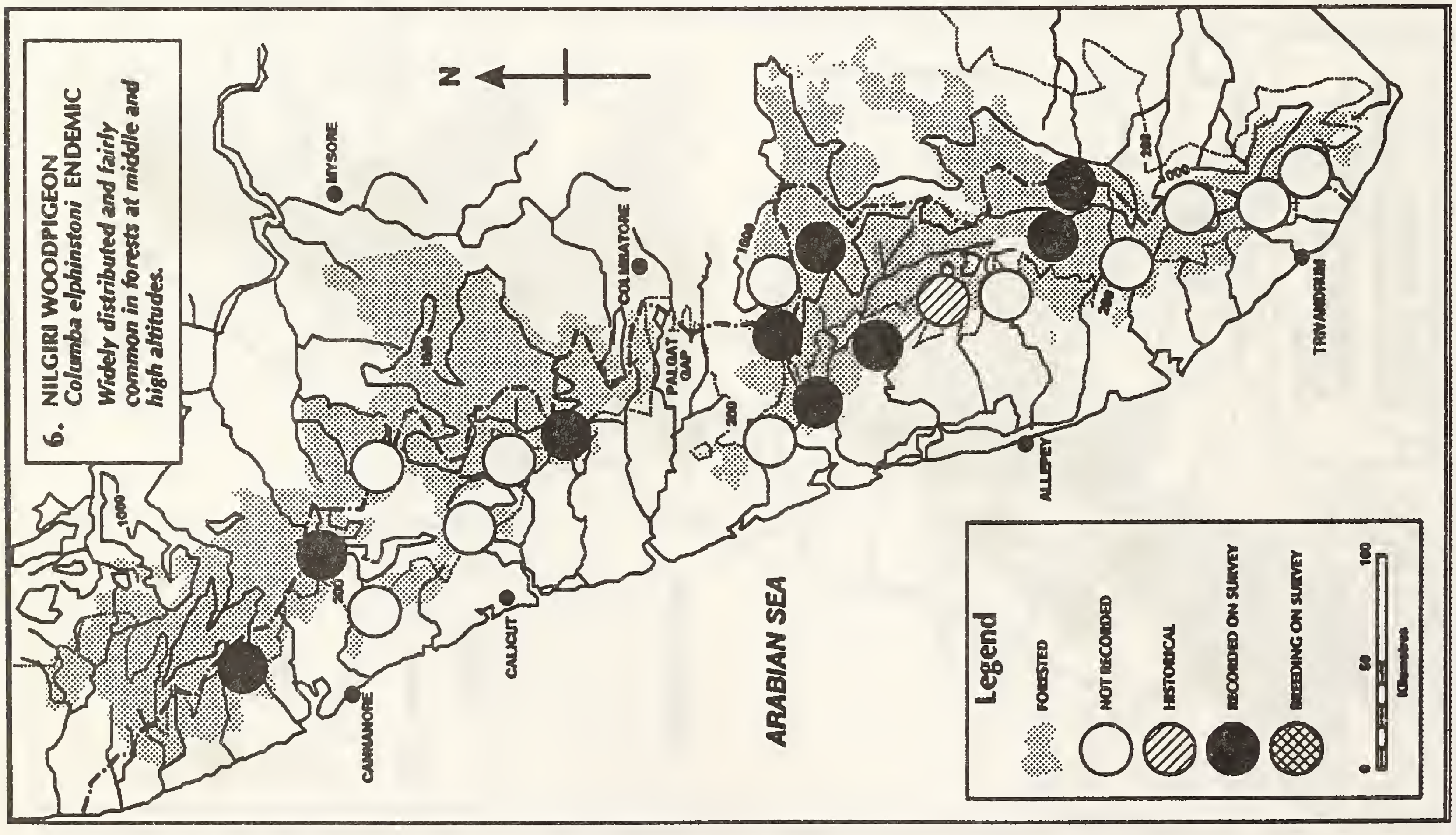
Kilometres


7. BLACK CRESTED BAZA
Aviceda leuphotes DISJUNCT

Locally distributed in open moist deciduous forest. Not uncommon where it occurs.

N
MYSORE
COIMBATORE
PALGAT GAP
CALICUT
CANNANORE
ALLEPEY
TRIVANDRUM
ARABIAN SEA
200
1000
Legend
FORESTED
NOT RECORDED
HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
100
Kilometres


6. NILGIRI WOODPIGEON
Columba elphinstoni ENDEMIC

Widely distributed and fairly common in forests at middle and high altitudes.

N
MYSORE
COIMBATORE
PALGAT GAP
CALICUT
CANNANORE
ALLEPEY
TRIVANDRUM
ARABIAN SEA
200
1000
Legend
FORESTED
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HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
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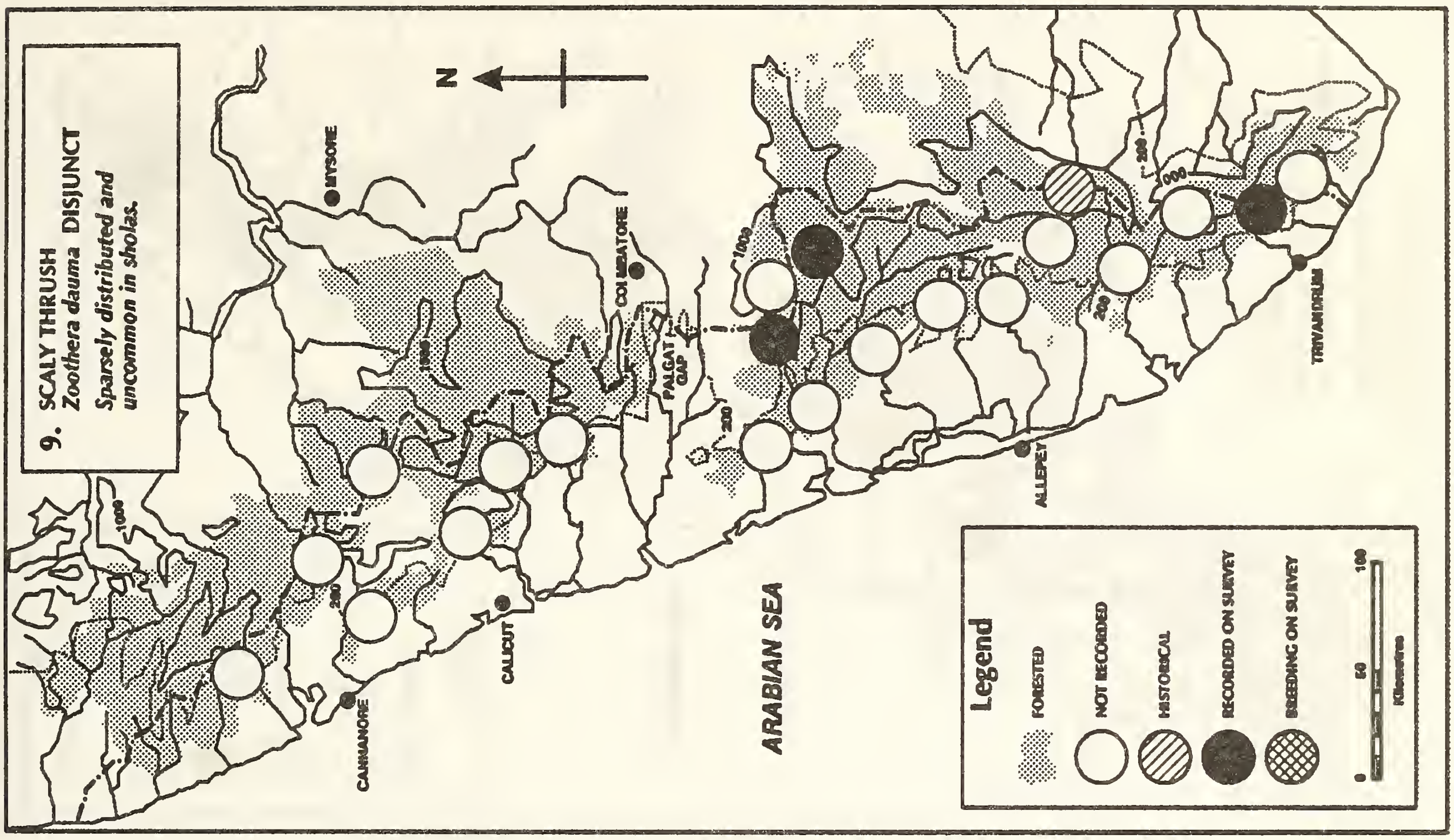
Kilometres



9. SCALY THRUSH *Zoothera dauma* DISJUNCT

Sparsely distributed and uncommon in sholas.

N
MYSORE
COIMBATORE
PALGAT GAP
CANNANORE
CALICUT
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
200
Legend
FORESTED
NOT RECORDED
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RECORDED ON SURVEY
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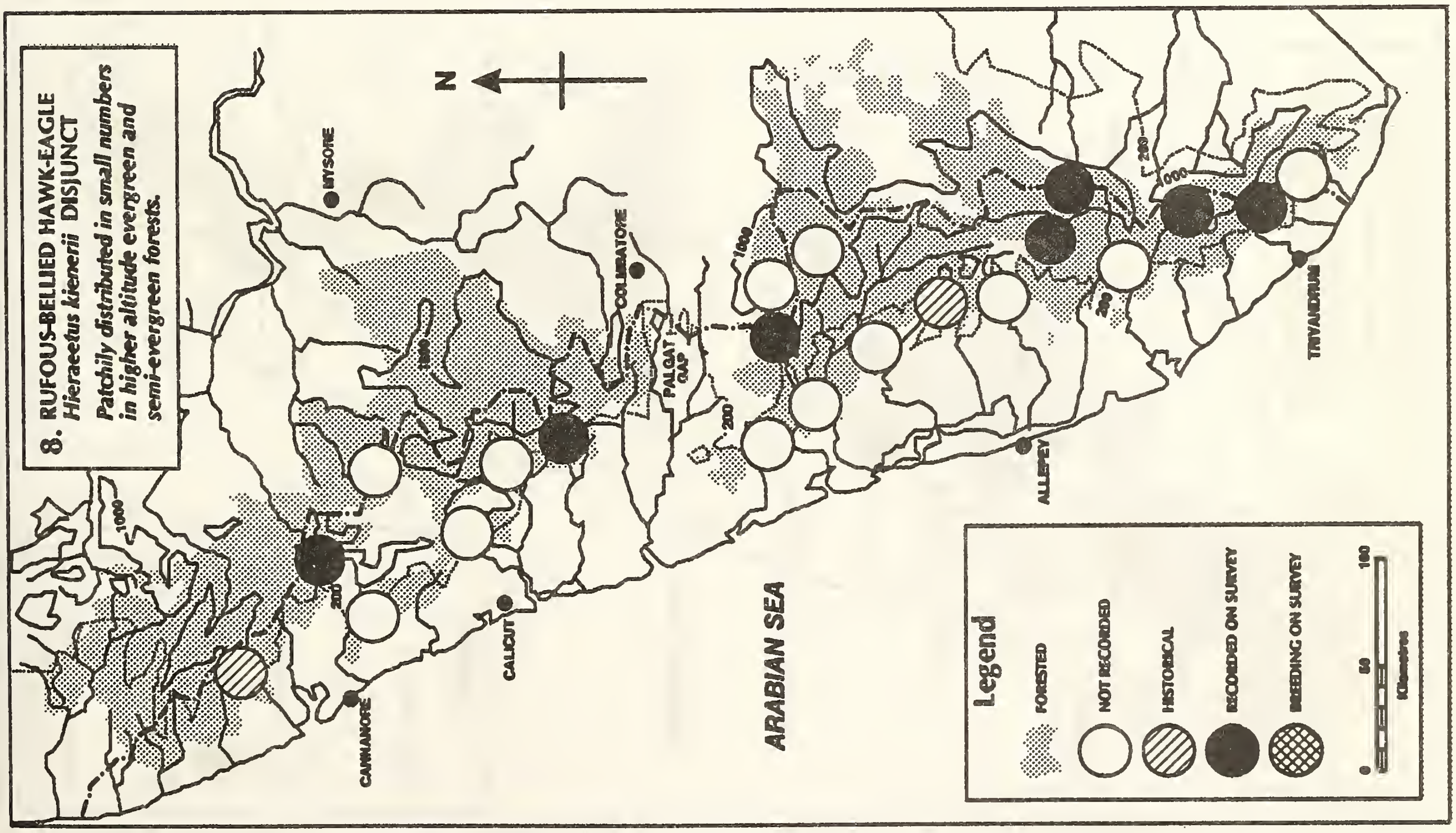

8. RUFOUS-BELLIED HAWK-EAGLE *Hieraaetus kienerii* DISJUNCT

Patchily distributed in small numbers in higher altitude evergreen and semi-evergreen forests.

N
MYSORE
COIMBATORE
PALGAT GAP
CANNANORE
CALICUT
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
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Legend
FORESTED
NOT RECORDED
HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
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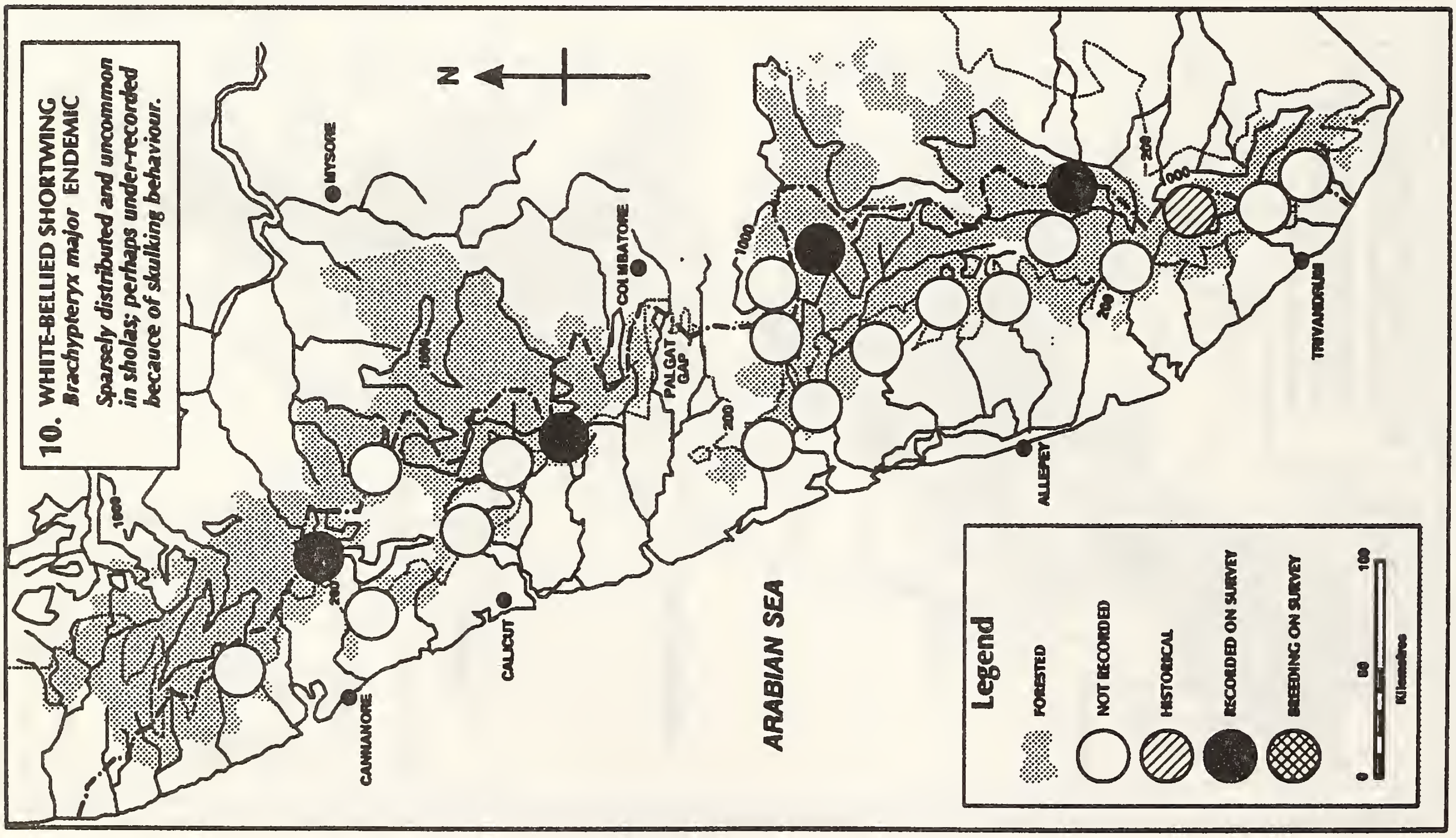
100
Kilometres



10. WHITE-BELLIED SHORTWING
Brachypteryx major ENDEMIC

Sparsely distributed and uncommon in sholas; perhaps under-recorded becauce of skulking behaviour.

N
MYSORE
COIMBATORE
PALGAT GAP
CALICUT
CANNANORE
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
200
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FORESTED
NOT RECORDED
HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
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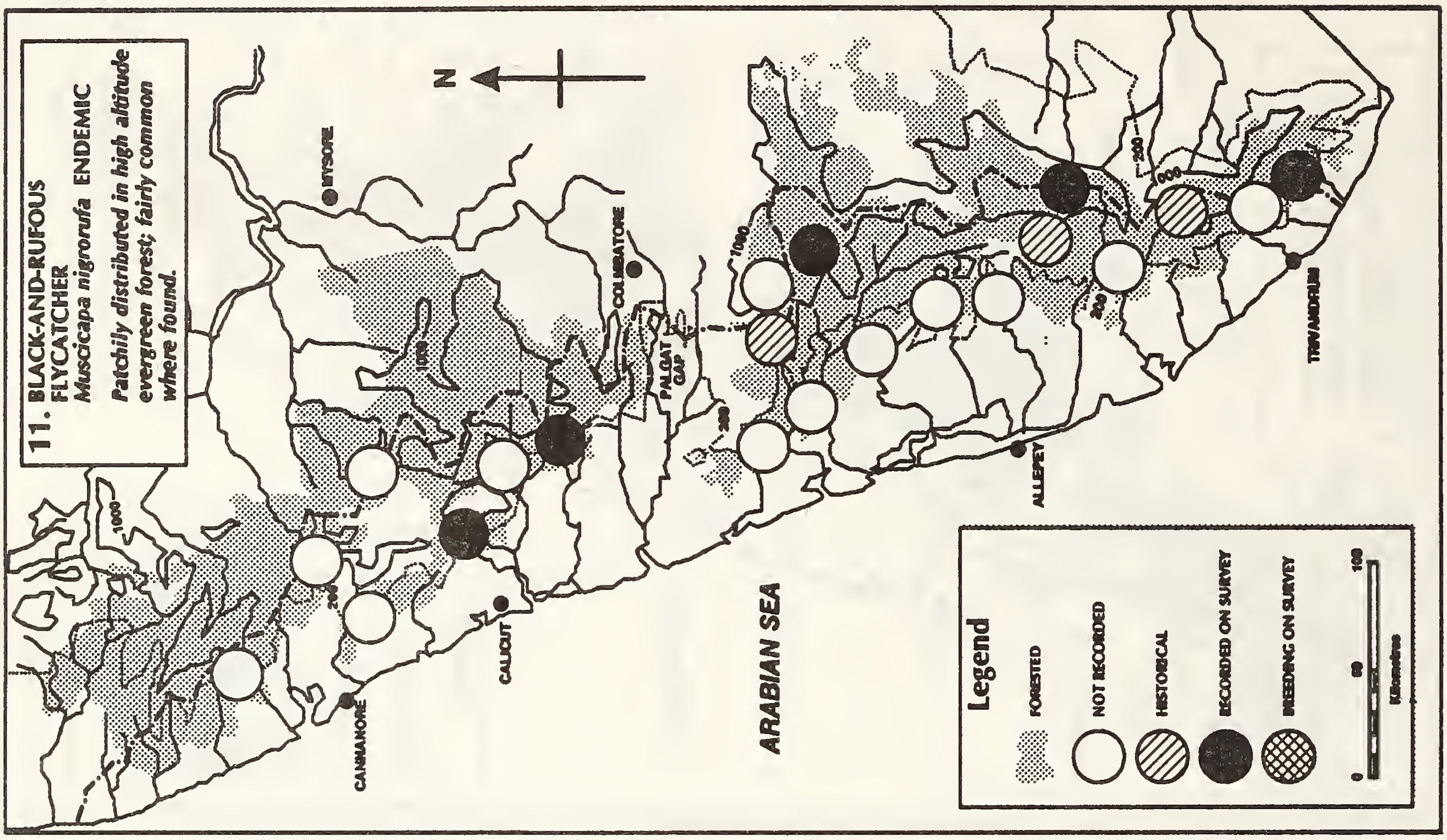
Kilometres



11. BLACK-AND-RUFOUS FLYCATCHER
Muscicapa nigrorufa ENDEMIC

Patchily distributed in high altitude evergreen forest; fairly common where found.

N
MYSORE
COIMBATORE
PALGAT GAP
CALICUT
CANNANORE
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
200
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FORESTED
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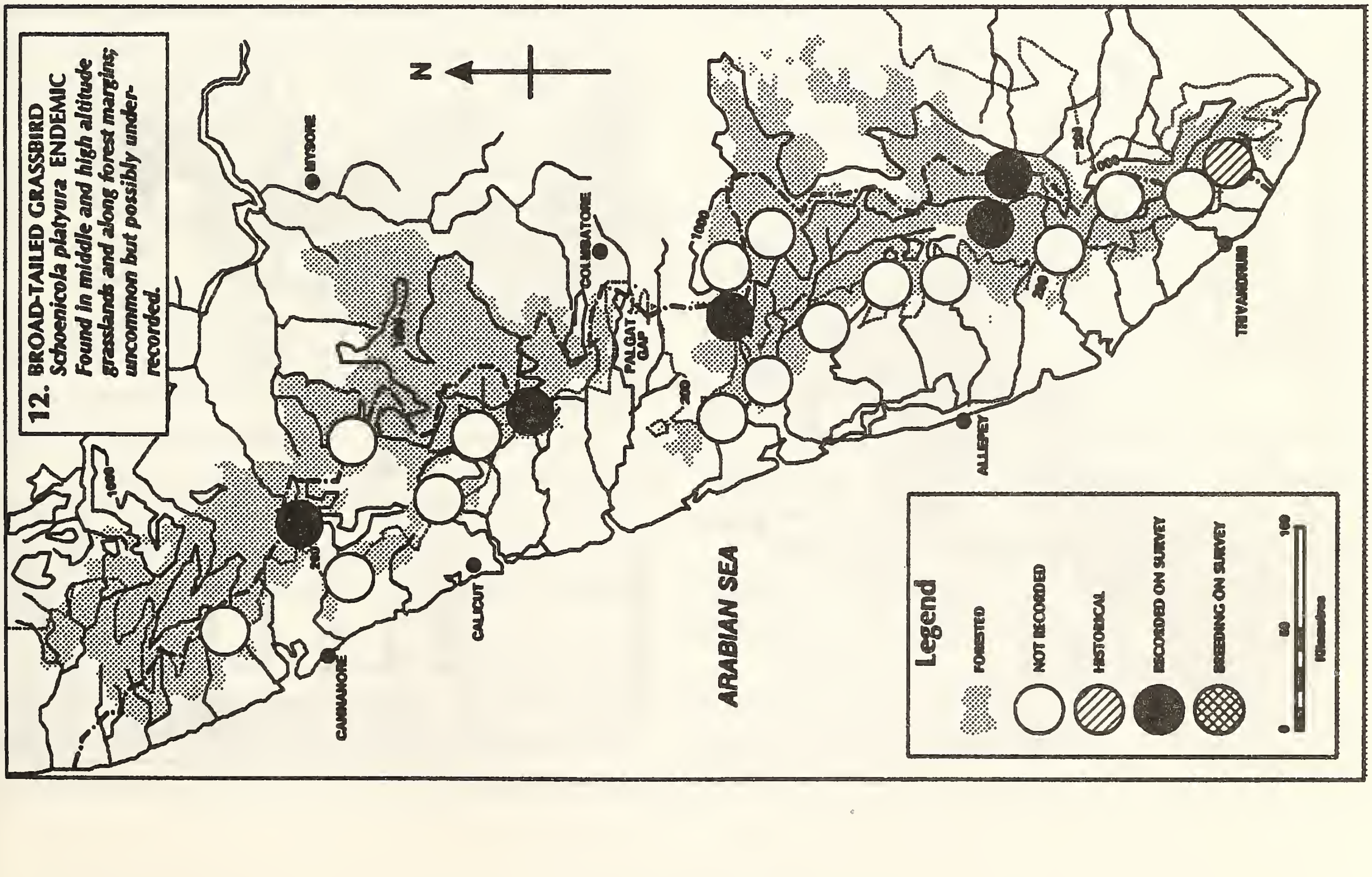
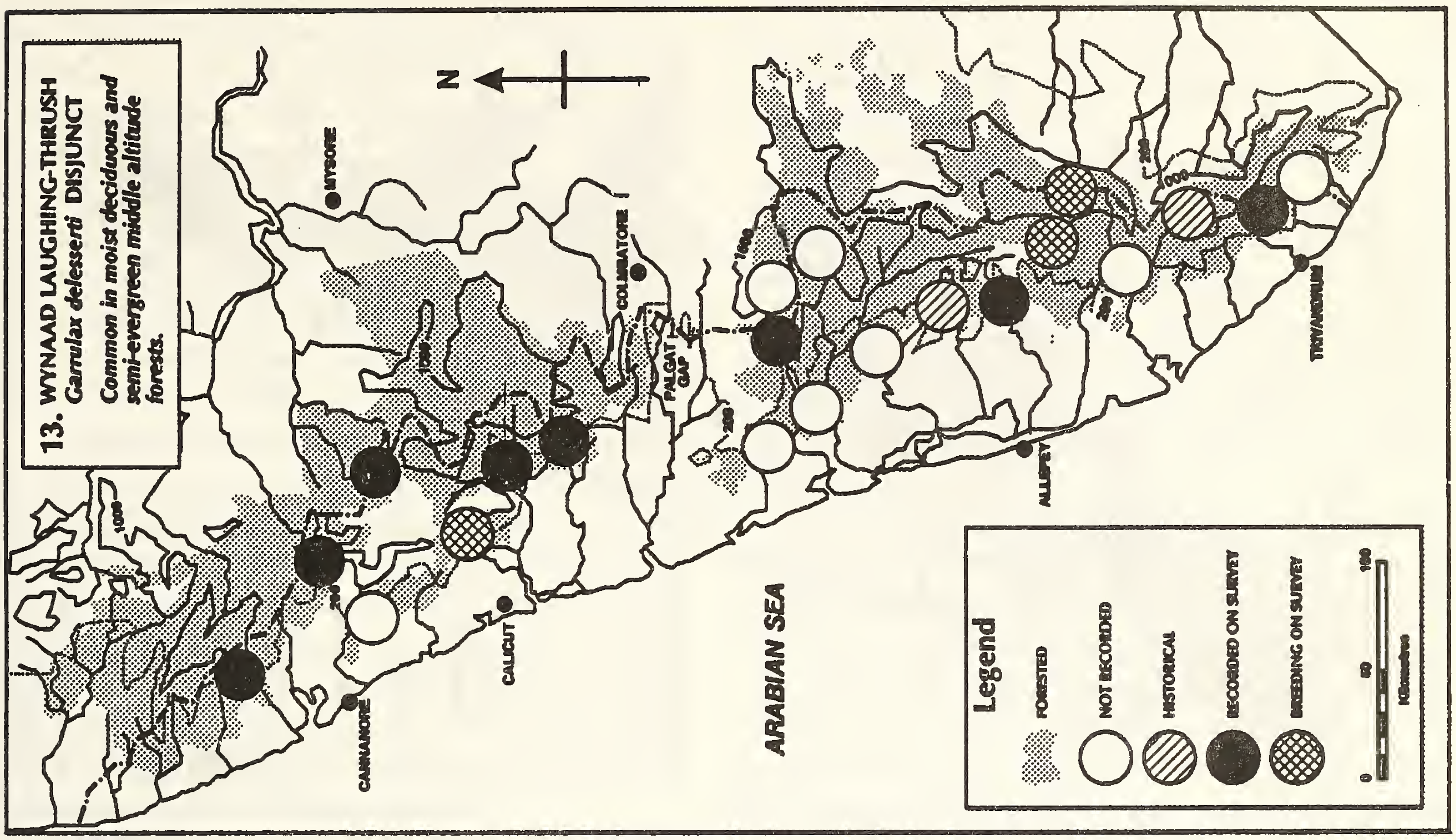


12. BROAD-TAILED GRASSBIRD
Schoenicola platyura ENDEMIC
Found in middle and high altitude grasslands and along forest margins; uncommon but possibly under-recorded.

N
MYSORE
COIMBATORE
PALGAT GAP
CANNANORE
CALICUT
ALLEPEY
TRIVANDRUM
1000
200
ARABIAN SEA
Legend
FORESTED
NOT RECORDED
HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
100
Kilometres



13. WYNAAD LAUGHING-THRUSH
Garrulax delesserti DISJUNCT
Common in moist deciduous and semi-evergreen middle altitude forests.

N
MYSORE
COIMBATORE
PALGAT GAP
CANNANORE
CALICUT
ALLEPEY
TRIVANDRUM
1000
200
ARABIAN SEA
Legend
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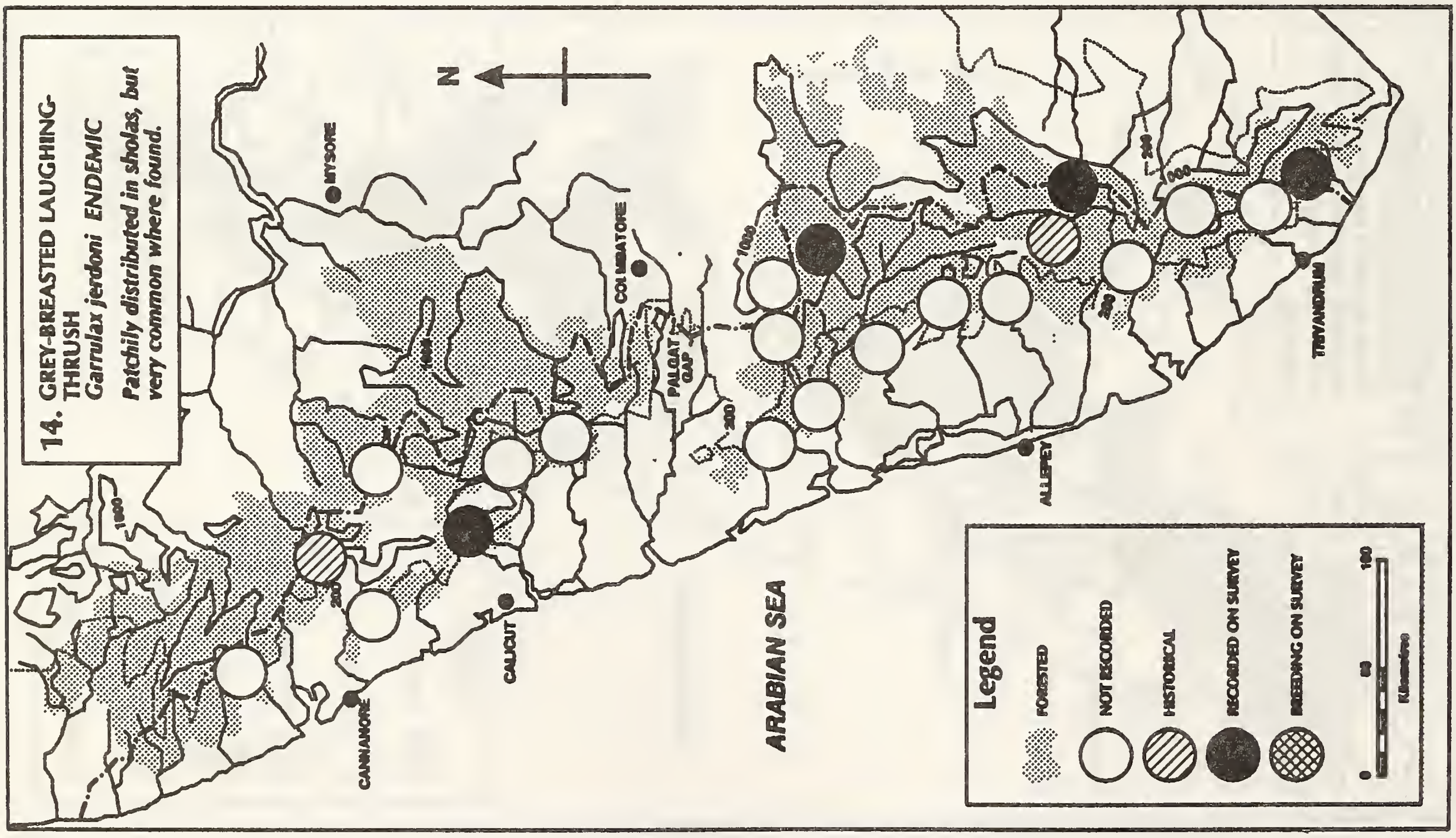

14. GREY-BREASTED LAUGHING-THRUSH
Garrulax jerdoni ENDEMIC

Patchily distributed in sholas, but very common where found.

N
MYSORE
COIMBATORE
PALGAT GAP
CALICUT
CANNANORE
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
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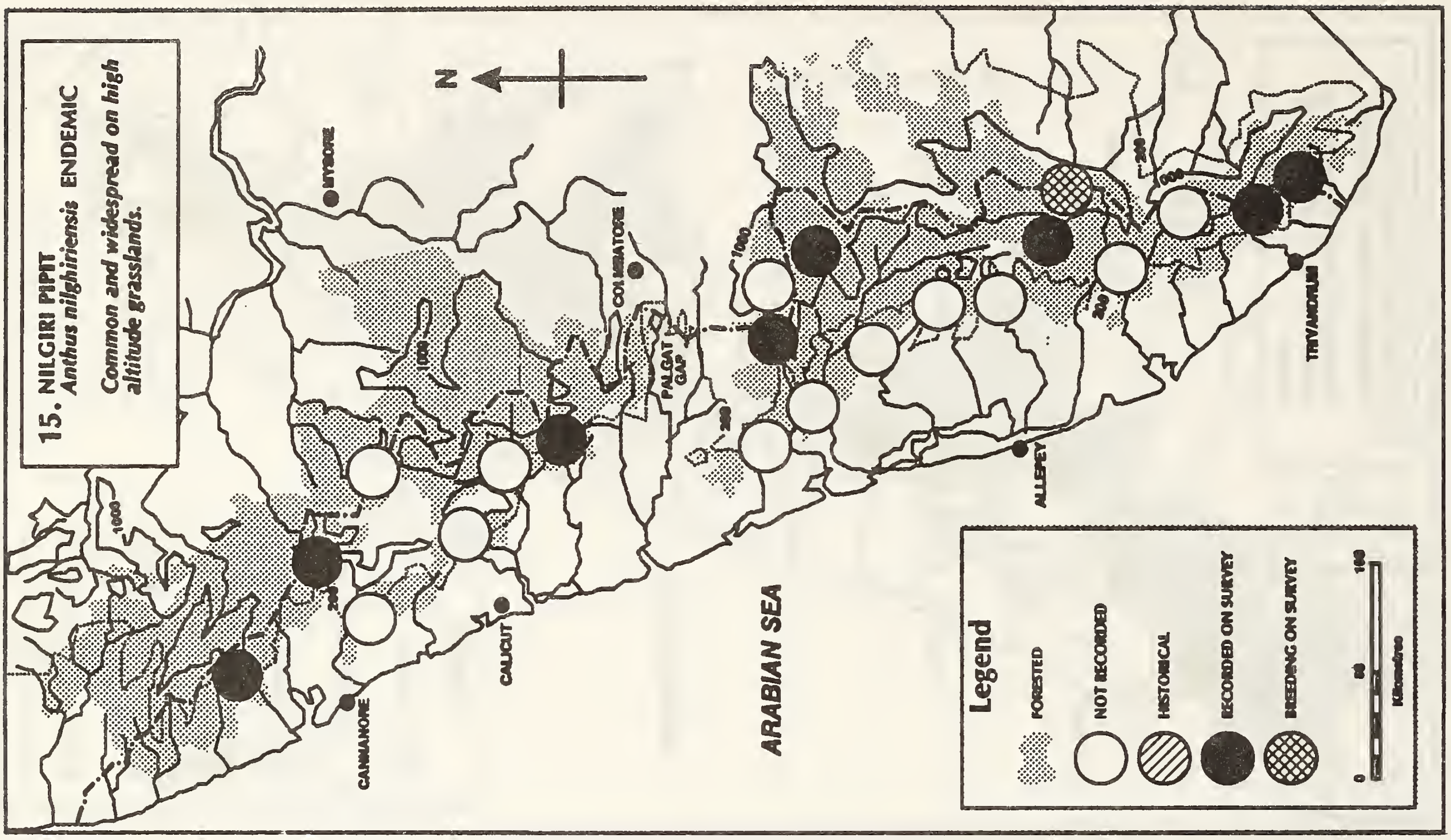

15. NILGIRI PIPIT
Anthus nilghiriensis ENDEMIC

Common and widespread on high altitude grasslands.

N
MYSORE
COIMBATORE
PALGAT GAP
CALICUT
CANNANORE
ALLEPEY
TRIVANDRUM
ARABIAN SEA
1000
200
Legend
FORESTED
NOT RECORDED
HISTORICAL
RECORDED ON SURVEY
BREEDING ON SURVEY
0
50
100
Kilometres

(Great Hornbill *Buceros bicornis*, map 1; Malabar Pied Hornbill *Anthroceros coronatus*, Malabar Grey Hornbill *Ocyceros griseus*, Threetoed Kingfisher *Ceyx erithacus*, Malabar Whistling Thrush *Myiophoneus horsfieldii*, Southern Treepie *Dendrocitta leucogastra*, White-bellied Blue Flycatcher *Cyornis pallipes*). In addition, in comparison with the comments made by Ali (1969), the ranges of Great Hornbill and Nilgiri Wood Pigeon *Columba elphinstoni* seem to have contracted towards higher altitudes.

Status: Although our surveys have not been designed to determine population sizes, we can make some comments on the likely status of those species regarded as rare. We deal specifically with those species occurring in forests and high altitude grasslands in Kerala that are recorded as "near threatened" by Collar *et al.* (1994). None of those occurring in the Western Ghats are believed to be vulnerable to extinction under the latest IUCN guidelines (Mace and Stuart 1994).

Grey Junglefowl *Gallus sonnerati*. Recorded at every locality, and also in coastal areas of Cannanore District, but otherwise rare at low altitudes. Suffers from egg collecting and hunting even in protected areas and is probably adversely affected by the removal of forest understory, but still common in some areas.

Nilgiri Wood Pigeon *Columbia elphinstonii*. This species was recorded at nine localities on our surveys, being uncommon to common everywhere it was found.

Ceylon Frogmouth *Batrachostomus moniliger*. Recorded breeding at Tirunelli, in Wynaad and at Parambikulam. It may be overlooked because of its nocturnal and rather silent behaviour, but apparently is uncommon.

Malabar Grey Hornbill *Tockus griseus*. Recorded in all localities and most common at low and middle elevations, hence apparently rather resistant to the effects of forest degradation.

Malabar Pied Hornbill *Anthracoceros coronatus*. Recorded on our surveys only in Wynaad and Nilambur, but also observed near Cannanore and Calicut outside forest areas and feeding on isolated figs. The species is most widely distributed at low altitudes and hence is probably under great pressure from habitat destruction.

White-bellied Shortwing *Brachypteryx major albiventris*. We found this species at four localities scattered throughout the State and there are previous records from a fifth locality. It was rare everywhere, but its shy disposition and adherence to dense undergrowth make it very hard to find. It may be commoner than it appears, but on the basis of our surveys probably warrants its "near-threatened" designation.

Wynaad Laughing Thrush *Garrulax delesserti*. Recorded in 11 areas on our surveys, in evergreen or semi-evergreen forest, mostly about 500 m. Uncommon to common throughout.

White-breasted Laughing Thrush *Garrulax jerdoni*. Recorded in 4 areas, with previous records from two more areas. Confined to *sholas*, but common where found and abundant in some areas.

Broad-tailed Grass Warbler *Schoenicola platyyura*. Recorded in five areas and previously reported from one other: rare or uncommon, but usually skulking, so probably overlooked.

Brown-breasted Flycatcher *Muscicapa muttui*. Present at most localities in evergreen or semi-evergreen forest, usually uncommon or common.

Black-and-orange Flycatcher *Muscicapa nigrorufa*. Recorded at five localities, with previous records at three more areas, in two of which we were unable to find it. Uncommon to common, but not abundant. The "near-threatened" designation appears appropriate for this species.

Nilgiri Flycatcher *Eumyias albicaudata*. Recorded in 10 localities, mainly in *shola* forests, and often common.

White-bellied Blue Flycatcher *Muscicapa pallipes*. Recorded in all localities, but not found in high *sholas*; generally uncommon.

Southern Treepie *Dendrocitta leucogastra*. Recorded at 19 localities and uncommon to common. Absent from the highest *sholas*.

CONCLUSIONS

Current trends in forest clearance for agriculture and plantations and encroachment by settlers, threatened especially the birds of low and middle altitude forests. The present status of such birds as Malabar Pied Hornbill, Malabar Grey Hornbill, Great Eared Nightjar, Southern Treepie and White-bellied Blue Flycatcher seems to be markedly worse than that described by Salim Ali (1969) for the 1930s. These species, especially Broadbilled Roller and Black-crested Baza, are patchily distributed at low densities and may be vulnerable to extirpation from local areas. Higher altitude habitats, where many endemics occur, cover smaller areas, but are less threatened. However, some species occurring at low densities (Rufous-bellied Eagle, White-bellied Shortwing, Broad-tailed Grass Warbler) may be vulnerable to extirpation in the long term.

Kerala has a large network of protected areas (National Parks and Sanctuaries). Effective protection of those areas should be sufficient to maintain most species, although the coverage of low altitude forest is poor, so the remaining fragments should be carefully protected. There is continuous pressure on all habitats and bird populations will need to be carefully monitored in future if Kerala's endemic and disjunct populations are to be maintained.

ACKNOWLEDGEMENTS

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APPENDIX 1

DISJUNCT SPECIES FOUND IN KERALA FORESTS, BASED ON DISTRIBUTIONS GIVEN BY ALI AND RIPLEY (1987)

Crested Goshawk *Accipiter trivirgatus*
Black-crested Baza *Aviceda leuphotes*
Jerdon's Baza *Aviceda jerdoni*
Rufous-bellied Eagle *Hieraeetus kienerii*
Great Hornbill *Buceros bicornis*
Indian Goldenbacked Threetoed Woodpecker *Dinopium javanense*
Pigmy Woodpecker *Picoides nanus*
Malabar Trogon *Harpactes fasciatus*
Broadbilled Roller *Eurystomus orientalis*
Lesser Coucal *Centropus toulou*
Large Brown Throated Spinetailed Swift *Chaetura gigantea*
Ceylon Frogmouth *Batrachostomus moniliger*
Great Eared Nightjar *Eurostopodus macrotis*
Fairy Bluebird *Irena puella*
Large Woodshrike *Tephrodornis gularis*
Smallbilled Mountain Thrush *Zoothera dauma***
Eurasian Blackbird *Turdus merula***
Hill Myna *Gracula religiosa*
Fantail Warbler *Cisticola exilis*
Wynaad Laughing Thrush *Garrulax delesserti***
Little Spiderhunter *Arachnothera longirostris*

** Found predominantly at higher elevations.

AERIAL DISPLAY IN THE LESSER FLORICAN

R. SANKARAN[1]

(*With four text-figures*)

The aerial display of the lesser florican, an endangered bustard endemic to the Indian subcontinent is described. The changes in display patterns, an increase in site specificity of display, has been correlated to height of grass and increased rates of display. The preference for males to display in cloudy and cool conditions has been quantified.

INTRODUCTION

Aerial displays have been described in several species of birds (e.g. Storor 1940, Van Tyne and Berger 1959, Sutton 1981). Courtship displays in the bustard group include aerial displays which are performed by the smaller members, and are of two kinds. One of these is a display leap or jump and is present in the smallest members of the group, the little bustard *Tetrax tetrax* (Shulz 1985) and the lesser florican *Sypheotides indica* (Dharmakumarsinhji 1950, Ridley *et al.* 1985). The other is a display flight and is seen in small African bustards such as the black bellied *Eupodotis melanogaster,* buff crested *Eupodotis ruficrista,* and black *Eupodotis afra* (Johnsgard 1991), and in the Bengal Florican *Houbaropsis bengalensis* (Narayan and Rosalind 1988).

The lesser florican is an endangered endemic bustard of the Indian subcontinent. Its breeding system has been defined as the dispersed lek (Sankaran, in press), and it breeds during the southwest monsoon (Jerdon 1864, Dharmakumarsinhji 1950, Ali and Ripley 1969). During this period, the species exhibits a nomadic movement into Gujarat, eastern Rajasthan, and western Madhya Pradesh, where it congregates in areas of good rainfall. The primary breeding habitat is grasslands, almost devoid of trees which are generally of the *Sehima nervosum - Chrysopogon fulvus* type.

An important component in the understanding of a species breeding behaviour, is a knowledge of the displays that are performed in connection with breeding. Considerable literature is available on the general behaviour of the lesser florican as it was a popular game bird (e.g. Jerdon 1864, Baker 1921), its displays have been described (Dharmakumarsinhji 1950), and quantified (Ridley *et al.* 1985). Two displays related to breeding have been described in the male lesser florican ((Dharmakumarsinhji 1950). Aerial (jumping) displays are performed irrespective of the presence or absence of females or rival males, and probably serve both functions of attracting females and signalling territory possession. The second display is a pre-copulatory one, and is directed towards and performed only in the presence of females. In this paper, I quantitatively describe and discuss the aerial displays in the lesser florican with respect to temporal variations in aerial display patterns in the breeding season and the influence of weather on display rates.

STUDY AREA

I studied the lesser florican at three main grassland sites. The majority of the data was collected at the Naulakha grassland within the Sailana Kharmor Sanctuary in Ratlam district, Madhya Pradesh. Livestock are grazed in the Naulakha grassland for the first few weeks of the monsoon after which grazing is stopped. In 1988, the lesser florican was studied at the Rampura-Movalia-Kalitalai grasslands near Dohad in Panchmahal district, Gujarat. No grazing is permitted in the Rampura grassland.

METHODS

The study extended over 400 days between July 16 and October 6, 1985; June 22 and October

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10, 1986; June 16 and October 1, 1987; June 24 and October 6, 1988. This study is based on direct observations of unmarked male lesser florican. Behavioural observations conformed to the focal animal sampling method (Altmann 1974). There were two principal methods of data collection. In 1985 and 1986, a lesser florican was located at dawn, and continuously observed until noon. The following day, a male was located at noon (if territorial, the same territory as on the previous day) and observed until dusk. Changes in activity to the nearest minute, and the total number of jumps in a five minute period were noted. This was modified in 1988, and observations were made from dawn to 12 noon and from 1400 hours to dusk. Males were observed for 20 continuous minutes, followed by a 10 minute interval. During the observation period, the time of every jump and change in activity was recorded to the nearest second. This method was found superior as the lesser florican is very active and can perform display leaps as rapidly as once every 25 seconds.

Weather data recorded during observations included temperature recorded in the shade every half hour at the observation point. Cloud cover was ranked as 0-25, 26-50, 51-75 and 75-100% of the sky. Similarly, rainfall was ranked as light drizzle, moderate drizzle and rain, and wind into light, medium and strong. Every change in the weather condition was noted to the nearest second.

Mean weekly grass height was calculated from sites at a minimum of 30 randomly selected points where maximum grass length was measured. Each study area had about five such sampling sites. Additionally, grass height at lesser florican 'jumping spots' was measured at 0, 1, 5, 10 and 25 m along North, South, East and West axis, with the jumping spot being the point of their bisection.

Statistical analyses were done on computer using Lotus 123 and Systat following guidelines laid down by Fowler and Cohen (1986).

RESULTS

Description of the Aerial Display: The aerial display of the lesser florican is a vertical 'jump' (Fig. 1). The display is preceded by the bird standing, with its neck and head craned up, shuffling or stamping its feet. The white feathers of the throat and chin are erected and appear in some large males as a sort of white 'bib' and the neck feathers may be slightly fluffed up. The male abruptly faces the wind, retracts its head, crouches and leaps into the air by flexing its legs. Take off is followed by about 10 or more very rapid wing beats, which enables the male to reach a height of about 1.5 - 2 m, vertically above the spot of take off, the height being determined by the surrounding vegetation. During the ascent, the head is arched back, the neck feathers are slightly fluffed, and the auricular plumes are partly thrown forward. On reaching the peak of the ascent, the male drops back to the ground with its wings held partly closed and kept away from the body, and the legs are paddled a few times for balance. The bird crouches on landing, and then gradually raises itself up until fully erect, scanning the grassland around before performing the next display leap. All display leaps are performed into the wind, and on the few occasions when a male displayed at an angle to the wind it was invariably pushed off balance.

Each display jump lasts on average one second (min. = 0.8 s, max. = 1.1 s). During the peak of the breeding season, a male may spend 70 - 80% of the day in performing aerial display and related activities. The mean inter display leap duration is 40.23 seconds (SD = 40.06 s, max. = 613 s, min. = 4 s, n = 2396). Time lag between displays varies to some extent, depending on the degree of spot specificity and the weather conditions. The period in between display leaps is spent either in walking or foraging or standing and looking around.

Auditory signals of the Display Leap: The display jump is accompanied by a loud rattling or clapping auditory signal. This sound lasts about 0.4 to 0.5 seconds and is produced only during the ascent of the display flight. The sound consists of 7 or 8 individual sounds all similar in pitch and intensity (from sonograms; not presented here). This auditory signal of the display leap is made by the wings and is not a vocalization or produced by the clicking of the tongue as has been suggested by others

(Dharmakumarsinhji 1950, Osborne *et al.* 1984, Ridley *et al.* 1985). To produce this sound, the wings of the males have specialized pointed primaries which are not present in the female (Table 1). The exact mechanism by which this auditory signal is produced from the pointed primaries is not known. (The pointed primaries are present in non-breeding and sub-adult males, and are the final diagnostic difference between males and females).

Towards the peak of the breeding season, when males fly into their territories, they often land in the typical display flight pattern, with arched neck and head. When flushed, males often take to flight as in the display leap, before easing into regular flight. In both cases the auditory signal may be emitted.

Display Patterns: The breeding season of the lesser florican can be broadly classified into pre-territorial and territorial periods. The territorial period occupies most of the breeding season (1985: 42 of 71 days; 1986: 66 of 101 days) and can be classified into early, peak and end territorial periods. Within the territorial period, there are two patterns in display leaps. Spot specific display was when birds displayed continuously from a single spot without moving between jumps. Non-spot specific display was when the bird moved between jumps and when consecutive jumps were not performed from the same spot.

After arrival and until the establishment of territories (pre-territorial period), males are not site specific and spend most of the day foraging (Fig. 2). Males display occasionally but inconsistently. Towards the end of the pre-territorial phase, display becomes consistent with some degree of site specificity. Initially, after the establishment of territories, the major diurnal activity is 'Non-spot specific display' (NSS). The males spend most of their time foraging, constantly interrupting their foraging with display leaps. 'Spot specific display' (SSD) is relatively low during this period (Fig. 2). As the season progresses, NSS becomes less and SSD soon becomes the major diurnal activity.

This pattern varied between grassland sites, and between years, due to the effects of varying rainfall and grazing pressures. For instance, at the ungrazed Rampura grassland, the pre-territorial

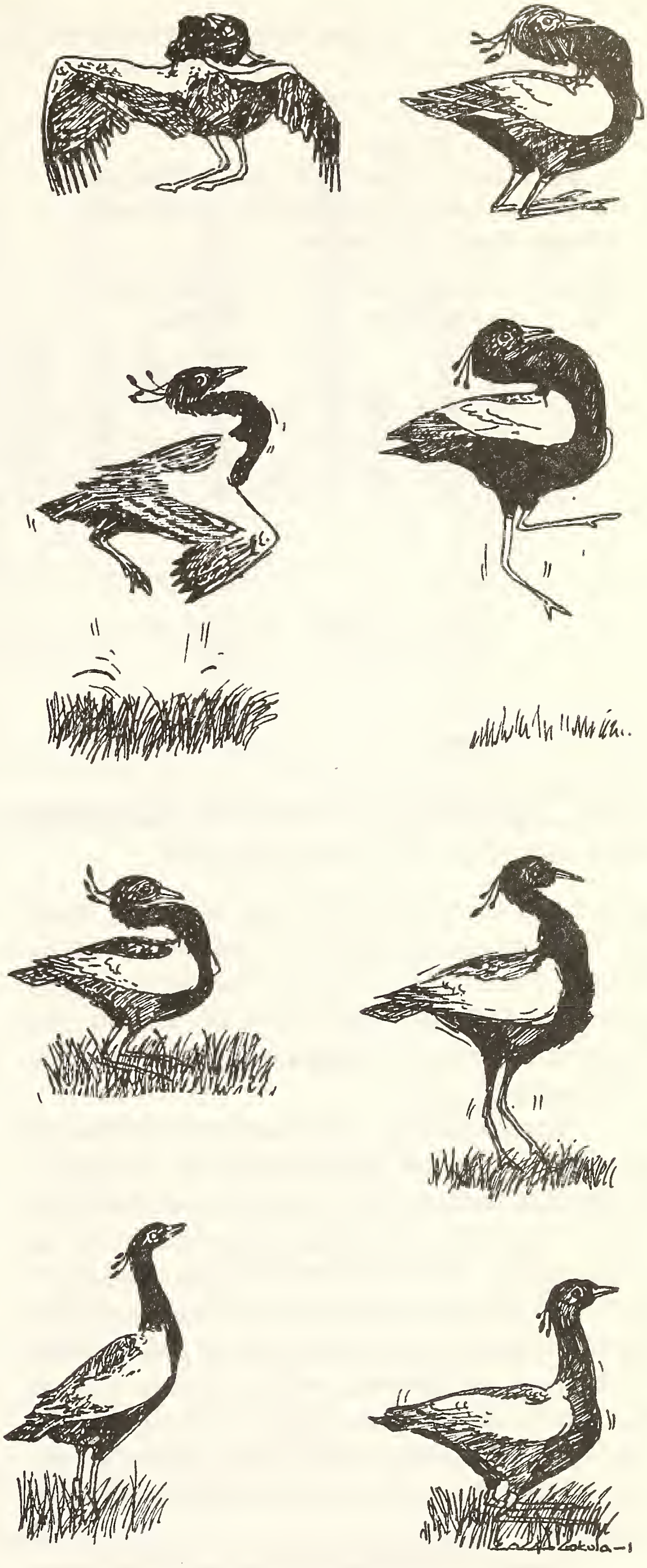

Fig. 1. Aerial display of the lesser florican.

TABLE 1
PRIMARY FEATHERS ON THE WINGS OF THE LESSER FLORICAN

Male			Female		
Wing length = 195 mm 11 primaries; overall narrow & pointed. First primary normal; Eleventh primary minute; outer primaries narroewr than inner primaries.			Wing length = 233 mm 11 primaries; overall slightly narrow. Primaries 1 to 5 normal; Primary 6 slightly narrowed; 7 to 10 distinctly tapered; Outer primaries narrower than inner.		
Prim. Nos.	Length (mm) of Notched Part	Width (mm) of Notched Part (at middle)	Prim. Nos.	Length (mm) of Notched Part	Width (mm) of Notched Part (at middle)
1	normal	-	1	normal	-
2*	46.0	8.3	2	normal	-
3	45.5	7.7	3	normal	-
4	51.1	7.7	4	normal	-
5	62.7	7.2	5	normal	-
6	56.7	6.7	6*	45.5	12.5
7	55.5	4.4	7	50.5	10.0
8	54.4	4.4	8	45.5	9.5
9	52.8	3.8	9	52.2	7.5
10	51.0	2.9	10	53.3	5.5
11	minute	-	11	minute	-

* Notch not distinctive.
(Data from one skin each of male and female from the BNHS collection For description of the pointed primaries in males see Jerdon 1864, Baker 1921, Ali and Ripley 1969).

period was brief and NSS phase was very brief. At the Naulakha grassland, however, the entire display patterns, i.e. the pre-territorial period, changing NSS and SSD were prominent and extended as a result of staggered grass growth due to livestock grazing.

Throughout the early and peak territorial periods, male lesser floricans display throughout the day, but more so in the mornings and evenings. This is especially true during cloudy days, when males display with very brief breaks throughout the day. Towards the end of the breeding season, due to an increase in day temperatures and a waning of display intensities, males display almost exclusively in the mornings or evenings. However, even during the waning of the breeding season males tend to display for brief periods in the afternoon.

Change in Display Patterns with Grass Height: When the frequency of spot specific display was regressed against grass height a significant increase in spot specificity was seen with an increase in grass height ($r = 0.889$, $df = 6$, $p<0.01$; Fig. 3a and 3b). At Naulakha grassland, early grazing resulted in lower grass growth rates and net grass heights than in Rampura which was not grazed during the monsoon. Percentage of spot specificity in relation to non-specific display was higher at Rampura than at Naulakha for the same time scale (Fig. 3a and 3b).

When rainfall is below normal, less dense vegetation may result in greater time spent in non-spot specific jumping than spot specificity. Similarly, those males which display from or close to the edge of crop fields are less prone to be spot specific and tend to display from various locations within their territories.

Time lag between jumps: The time lag between two consecutive jumps was significantly shorter when males displayed from a specific

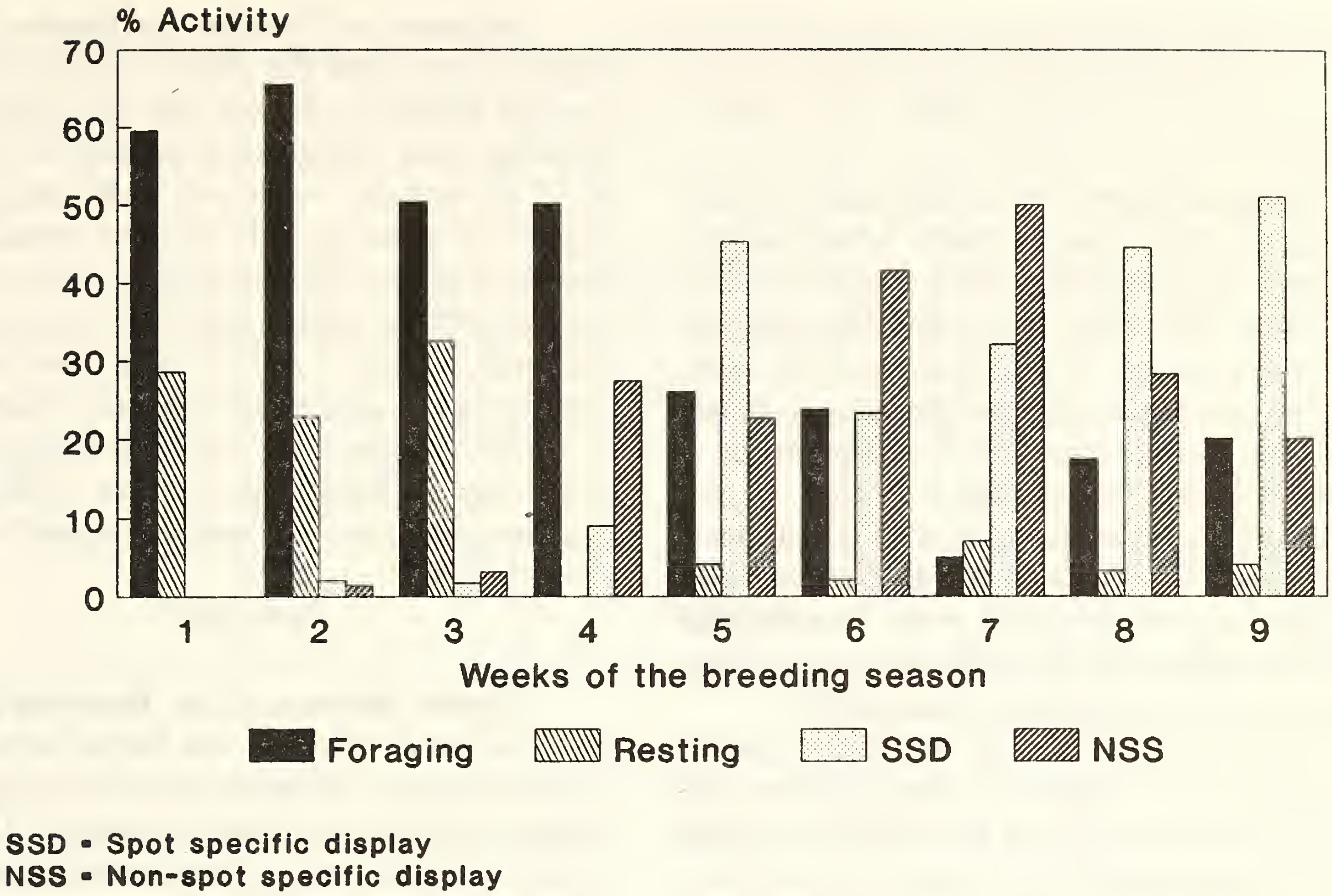

Fig. 2. Changes in display patterns between pre - and peak territorial periods in the lesser florican.

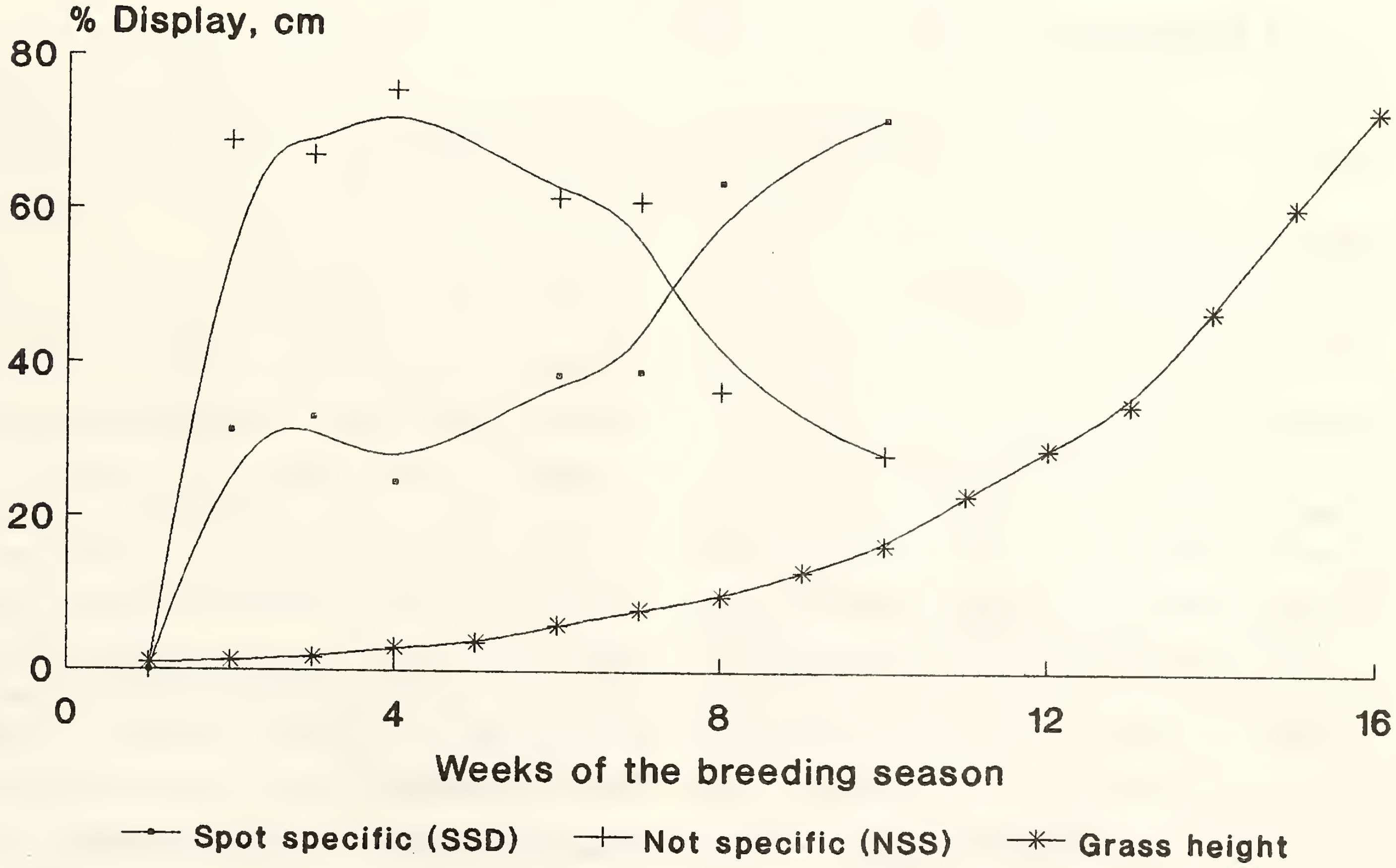

Fig. 3a. Variation in spot specific display with grass height in a grassland grazed in the early monsoon (Naulakha),

spot than when displaying from different spots (T-Test t = 7.100, $p < 0.0001$; mean SSD = 36.20 seconds, SD = 28.63; mean NSS = 58.13, SD = 62.62).

Jumping Spots: Males increasingly begin using a few locations from which they display. Usually at peak breeding period a male may have two to five such spots. These 'jumping spots' are one to two metres in diameter, with the earth trampled bare of all vegetation. Jumping spots may shift from time to time due to disturbances or excessive growth of vegetation. In areas of long grass, jumping spots are established in patches of shorter grass. In areas of short grass, jumping spots are close to a patch of long grass. In undulating terrain, jumping spots are located at the top of ridges and the ground immediately around is flat.

Fig. 4a and 4b (see pp. 408, 409) represent grass height at 1, 5, 10 and 25 metres along the north, south, east and west axis at four different jumping spots. The jumping spots are centrally located in a 'saucer' where grass height increases from the centre to the periphery.

Influence of Weather on Display Rates: Display rates were the highest under cloudy or overcast conditions. Lower rates of display occur under sunny or partly cloudy conditions (Tables 2 & 3). Under rainy conditions males displayed at highest rates during light drizzles, while strong drizzles and rainy weather caused males to reduce significantly the display rates or to cease displaying totally (Tables 2 & 3). Display rates were the same under all wind speed conditions (Tables 2 & 3). When display rates were correlated against temperature, a significant decrease in the rate of display was seen as temperature increased ($r = -0.52$, df = 24, $p<0.02$).

DISCUSSION

Display patterns in the Breeding Season: The onset of territoriality and display in the lesser florican is phased. In the pre-territorial period aerial display in males is an inconsistent activity. The onset of territorial behaviour is characterised by sustained aerial display. Once the males become territorial, the time spent in display does not appear to vary

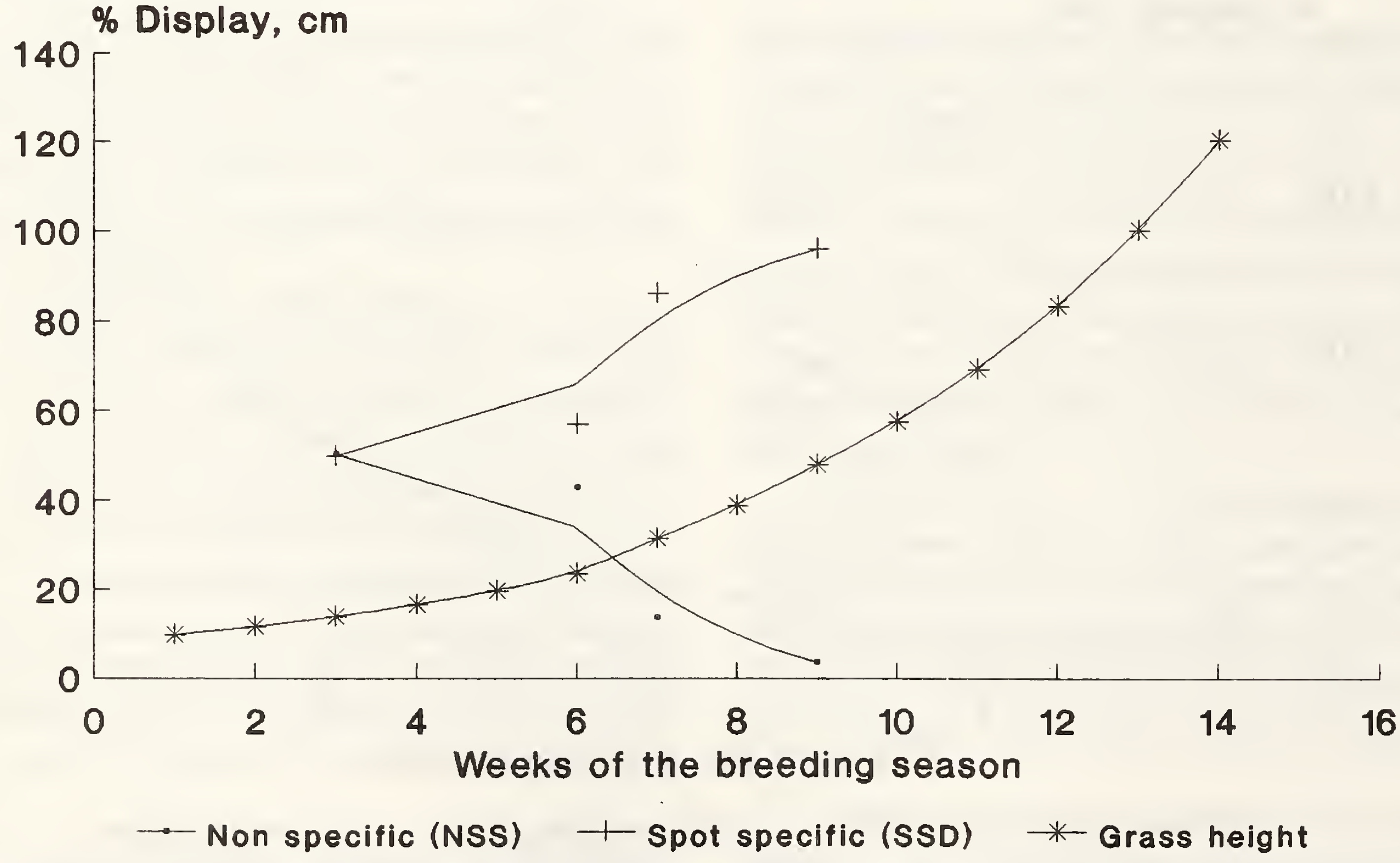

Fig. 3b. Variation in spot specific display with grass height in a grassland not grazed during the monsoon (Rampura).

TABLE 2

BASIC STATISTICS FOR DISPLAY RATES (LEAPS/MINUTE) UNDER DIFFERENT WEATHER CONDITIONS

	W1	W2	W3	W4	R1	R2	R3	R4	B1	B2	B3
N	13	25	27	94	27	11	12	122	70	42	21
Minimum	0	0	0	0	0	0	0	0	0	0	0
Maximum	1.93	2.3	3	3.7	2	1.39	0.14	3.12	3.08	1.93	2.25
Mean	0.75	0.92	1.29	1.39	0.92	0.45	0.02	1.22	1.06	1.14	1.01
SD	0.75	0.79	0.95	0.79	0.57	0.51	0.05	0.8	0.86	0.6	0.65

TABLE 3

EFFECTS OF WEATHER ON DISPLAY RATES (MANN WHITNEY U TEST, DF=1)

Cloud cover	W2		W3		W4	
	U	P	U	P	U	P
W1	144.0	0.57	120.0	0.11	342.0	0.01
W2			264.0	0.18	813.5	0.02
W3					1191.0	0.63

Rain intensity	R2		R3		R4	
	U	P	U	P	U	P
R1	217.5	0.03	296.0	0.01	1265.5	0.06
R2			104.0	0.01	298.5	0.01
R3					98.5	0.01

Wind speed	B2		B3	
	U	P	U	P
B1	1347.5	0.46	739.5	0.97
B2			500.5	0.39

Key for Tables 4.2. a to 4.4. b
W1 = 0-25% cloud cover; W2 = 25-50% cloud cover; W3 = 50-75% cloud cover;
W 4 = 75-100% cloud cover. B1 = breeze; B2 = moderate wind; B3 = strong wind;
R1 = light drizzle; R2 = strong drizzle; R3 = rain; R4 = No rain or drizzle.

significantly between days. Males spend 70% or more of the day in display activities for most of the territorial phase. Variations in the time spent in display, can be attributed to fluctuations in daily weather conditions. On a predominantly rainy or a hot sunny day, males display less, irrespective of whether they are in the early or peak display phase.

What does vary over the territorial phase is the nature of the display leap, i.e. whether the male moves between leaps or displays from a fixed spot. During the early territorial phase, males move constantly between display leaps. A decrease in such movement between leaps is simultaneous to an increase in spot specific display, until most displays are performed from a few 'jumping spots'. This change can be attributed to different reasons, and the degree of influence of each is yet to be determined.

First, the period of lowest spot specificity coincides with lower availability of food resources. In this period males have to spend more time in foraging over a wider area to fulfil nutritional needs and perhaps to build up a certain amount of energy reserves as well. Dharmakumarsinhji (1950) opined that 'when the birds have newly arrived, when they are in lean condition, they feed at all times of the day.' As the season progresses, insect life becomes considerably more abundant, and individuals would have to spend less and less time to fulfil nutritional requirements.

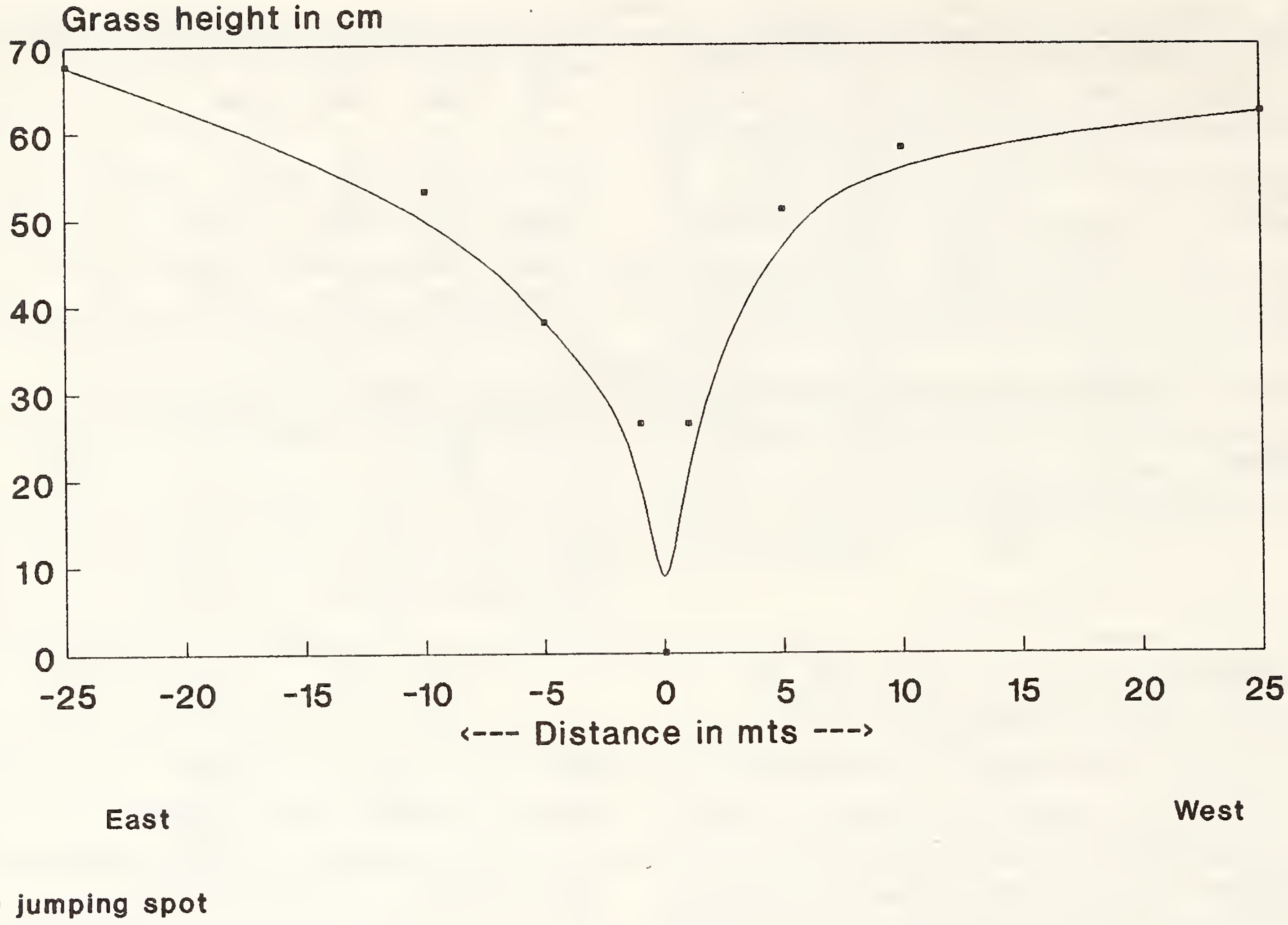

Fig. 4a. Grass height at jumping spots in the lesser florican

The second possibility, the only one which has been directly substantiated, deals with grass height. A strong positive correlation is seen between spot specific display and increasing grass height. This correlation can have three explanations: (a) On arrival of the floricans, the grassland is bare of vegetation. Sustained display at fixed sites, in the absence of sufficient cover, could greatly increase predation risks. Thus with increasing grass cover, males can display with relatively greater safety from fixed sites for longer durations; (b) As insect abundance is directly related to increasing grass height, spot specific display can be concomitant to that of nutritional demands; (c) Non-spot specific display occurs at a time when the grass height is short and free movement is possible. Once the grass grows tall, arbitrary choice of jumping spots will be hampered by the grass. Males may then return to fixed spots as these are trampled bare of vegetation, and are also set in patches of shorter grass. In grasslands where grass grows rapidly taller, as in Rampura, males spend far more time in spot specific display than in grasslands that have shorter net grass heights (Naulakha). In years of lower rainfall and shorter grasses, males tend to spend more time in non-spot specific display, than in years of greater grass heights.

Thirdly, if fitness of a male is advertised by frequency of display and thus enhances mating success, then as the breeding season progresses males should attempt to display at maximum frequencies. (The time lag between leaps was significantly lower in spot specific display than that of non-spot specific display). Thus a peak in display rates should be evident in early to mid-August when females become receptive. Males may achieve this, not by increasing time spent in display but by reducing movement between display which results in an increase in frequency of jumps.

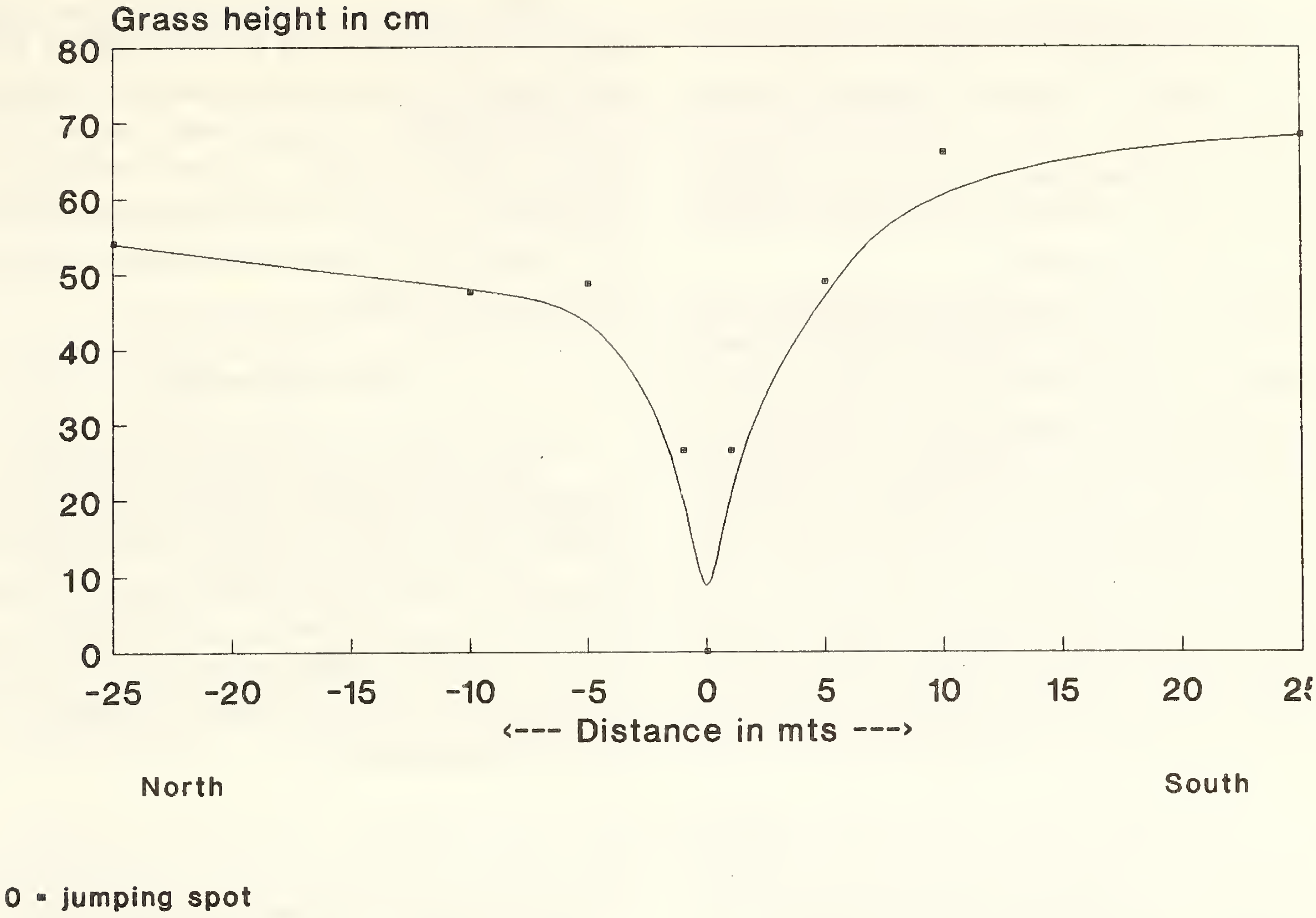

Fig. 4b. Grass height at jumping spots in the lesser florican

Effect of Weather on Display Rates: Several species of birds display mainly at dawn and dusk or at night and include among others the Sage Grouse (Gibson and Bradbury 1987) and the Great Snipe (Avery and Sherwood 1982, Hoglund and Robertson 1990). Other species of birds have been specifically associated with particular types of weather. For instance, the Mistle Thrush and the Red Flanked Blue Tail are both persistent songsters in rain and windy weather, and damp cloudy days with drizzle have been typically associated with the 'reeling' of the Grasshopper Warbler and the drumming display of the snipe. Elkins (1983) suggests that the rather unique sounds of those species associated with inclement weather may carry further under cloudy or overcast conditions.

The display leap of the lesser florican communicates both acoustic and visual signals over longer distances and should logically be performed most frequently during weather conditions that maximize the range of such signals. For instance, audibility is high when an inversion is present and may account for the high levels of bird song on clear calm mornings (Elkins 1983). Similarly, visibility is higher on clear days, and sunshine would better contrast the black and white plumage of the male lesser florican during its display leap. Yet males display at higher rates under overcast conditions when presumably both auditory and visual ranges are reduced. Then again, turbulence during strong winds reduces the audibility of acoustic signals (Elkins 1983), yet there is no significant difference in display rates under different wind speeds. That the leaps of the lesser florican are performed maximally during weather conditions that do not maximize the range over which these signals are communicated is of particular interest.

The frequency of bird song, rather than the audible range, is possibly of greater biological significance (Elkins 1983). For instance, in the Sage

Grouse, 'males that mated attended the lek more often, displayed at higher rates and scored higher on an acoustic component than those that did not mate (Gibson and Bradbury 1985). If display rates are associated with mating success, then males should display for as long a duration and at as high a rate as possible to maximize success.

If display rate is of greater significance in the lesser florican, then males should display at higher rates in those environmental conditions that require the least expenditure of energy, or more important, cause least stress to the individual. A high display rate in hot sunshine should cause thermo-regulatory stress on the individual. This is also indicated by the inverse correlation between display rates and temperature. Hence males display at higher rates in cloudy conditions, when heat stress must be least, than in sunny conditions when heat stress should be most (see also Ridley *et al.* 1985).

Under strong windy conditions, a male displaying as close as 50 m or less down wind is often inaudible to the human observer. Conversely, a bird displaying in strong up wind can be heard as much as 500 m away or more. Perhaps such compensation in open country result in the absence of a significant variation in display rates under different wind speeds.

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EFFECTS OF CLIMATE ON PALAEARCTIC WARBLERS OVER-WINTERING IN INDIA

Madhusudan Katti and Trevor Price[1]

(*With eleven text-figures*)

Human activities threaten many species with extinction worldwide. Migrant birds in Europe and North America include a number of well-studied examples of species undergoing contemporary population decline. In many cases, it is difficult to understand causes of the decline. We present results from a long-term population study of migrant warblers in India. We studied the Green Leaf Warbler *Phylloscopus nitidus* in Kalakad-Mundanthurai Tiger Reserve, south India over four winters (1992-96), and found significant effects of rainfall variation on population density and individual body condition. Winter rainfall affected both primary (leaf) and secondary (Arthropod) production, thereby affecting prey availability for the insectivorous warblers. These, in turn, were associated with differences in over-wintering persistence, body weight, and population density of the warblers. These effects were quite rapid, affecting densities within the first three months of the winter season. Records of long-term variation in rainfall suggest that warbler populations may fluctuate widely, even without overt changes to winter habitat. Such fluctuations make it difficult to detect declines due to other reasons, and also increase the risk of populations going extinct. Since most winter habitat appears to be saturated, we predict that any further loss of habitat will decrease the total population of the species.

Species extinction provides the most compelling evidence for the adverse environmental impact of humans. The evidence that many recent extinctions are indeed human driven comes from numerous case studies, which document the importance of introduced predators, parasites and competitors (e.g. Harris 1973, Hamann 1984, Savidge 1987, Pimm *et al.* 1955a, Steadman 1995), human hunting (e.g. the famous Passenger Pigeon, Blockstein and Tordoff 1985; many island species, Steadman 1995), and habitat loss through clearing for agriculture and timber (e.g. Terborgh 1989, Reichel *et al.* 1992, Rappole 1995, Steadman 1995). Such studies are augmented by estimates of the background rate of extinction, as obtained from the fossil record (Jablonski 1995). They show that we can expect an extinction spasm in the next century larger than any since the Cretaceous (*c.* 65 million years ago, Jablonski 1995, Pimm *et al.* 1995b). For birds, the rate of extinction is certainly higher now than it has ever been. Steadman (1995) presents zooarcheological evidence suggesting that as many as 2000 bird species — about 15% of the number of species present today (Sibley and Monroe 1990) — have gone extinct in the islands of the tropical Pacific, since humans first colonized the islands. The only plausible explanation for the increased rates of extinction is the presence of humans.

While case studies of extinction provide an important focus for conservation science, they are also a little frustrating for the conservationist, whose main aim is to preserve extant species. On the other hand, studies of declining populations, while providing information about the impact of a changing environment, also allow us the luxury of trying to reverse the decline.

A serious difficulty in the study of population declines is that, unlike the case of extinctions, we have no good estimates of natural population fluctuations before human intervention. It is clear that climate fluctuations can have a large impact, e.g. droughts causing heavy mortality (Gibbs and Grant 1987, Baillie and Peach 1992, Blake *et al.* 1992). There have been major changes in the geographical range for many species in Britain this century attributable to relatively minor climatic changes (Burton 1995). Over the past 2 million years, ice ages have caused extreme climatic changes which

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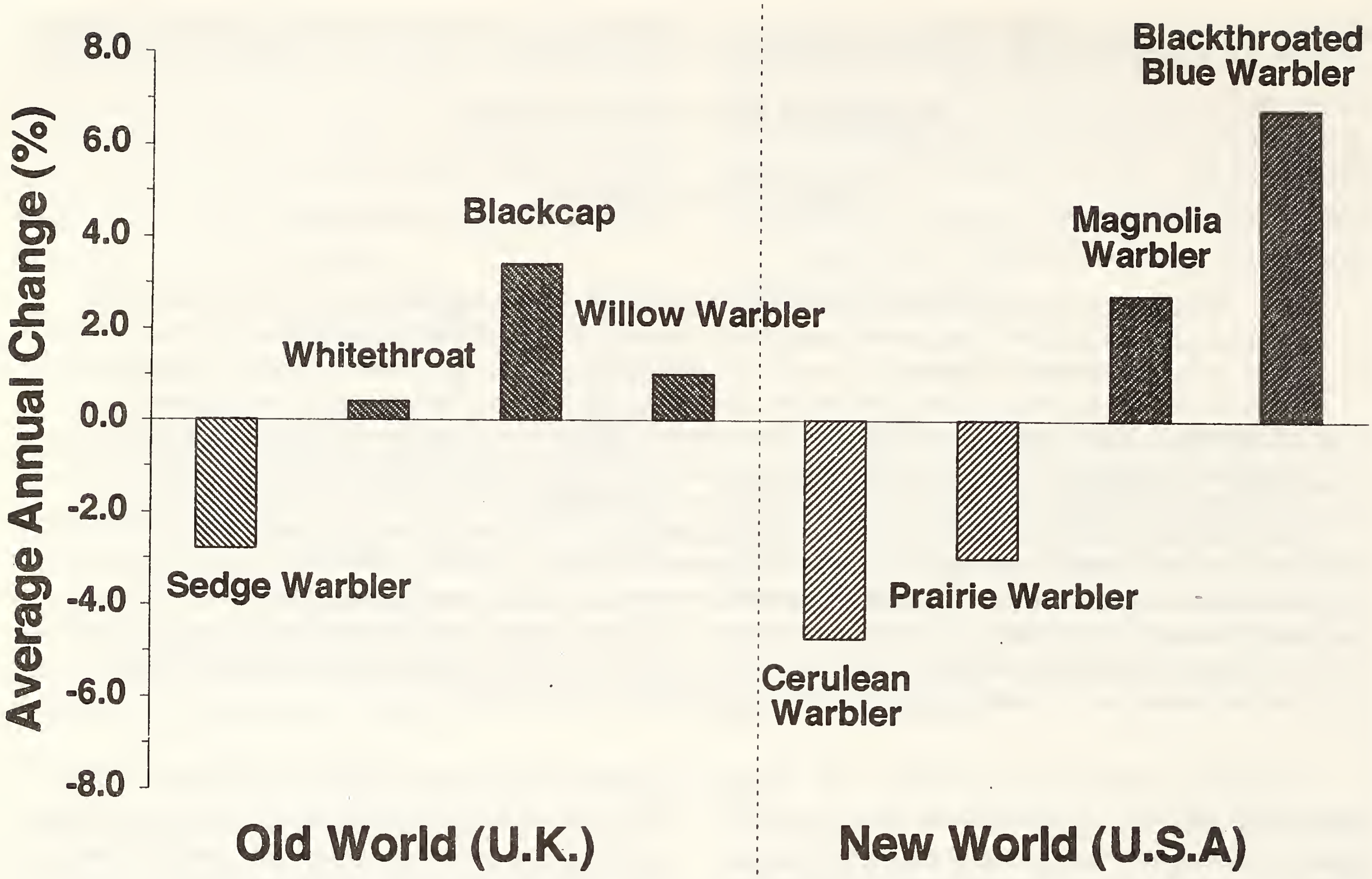

Fig. 1. Average annual changes (%) in several warbler species in Europe and North America in recent decades. Data for U.K. are from Baillie and Peach (1992), using British Trust for Ornithology (BTO) data for 1964-1989, while those for U.S.A. are from James *et al.* (1996), using Breeding Bird Survey (BBS) data for 1966-1992.

must have had an enormous impact on population sizes.

In this paper we evaluate the impact of climate — specifically winter rainfall — on population sizes of over-wintering migrant Palaearctic warblers in India, as a means by which to evaluate the non-human factors that can cause population fluctuations. We chose to focus on warblers because they have been well studied in Europe and North America, and have become a classic example of species in decline (Terborgh 1989, Hagan and Johnston 1992, Rappole 1995). Habitat loss has been implicated as a cause of decline for some specific case studies (Rappole 1995), but some outstanding questions remain. Firstly, not all species are declining (Fig. 1, Baillie and Peach 1992, James *et al.* 1996). Secondly, even for those species which are declining it can be difficult to detect a root cause, which may be on the breeding grounds, on the wintering grounds, or during migration (Böhning-Gaese 1992, Sherry and Holmes 1992, 1996, Böhning-Gaese *et al.* 1993). Third, a role for habitat loss has been difficult to demonstrate (Rappole and McDonald 1994, Rappole 1995, Sherry and Holmes 1996). These questions make it imperative to understand the impact of climate on population sizes.

We report results of a four-year study on the Green Leaf Warbler, *Phylloscopus nitidus*, on its wintering grounds. This species over-winters in south India, and breeds in the Caucasus (> 5000 km away, Cramp 1992). We studied the population over-wintering on Mundanthurai plateau in the Kalakad-Mundanthurai Tiger Reserve in the southern Western Ghats from December 1992 to January 1996. The prime purpose of this paper is to demonstrate a connection between rainfall and over-winter

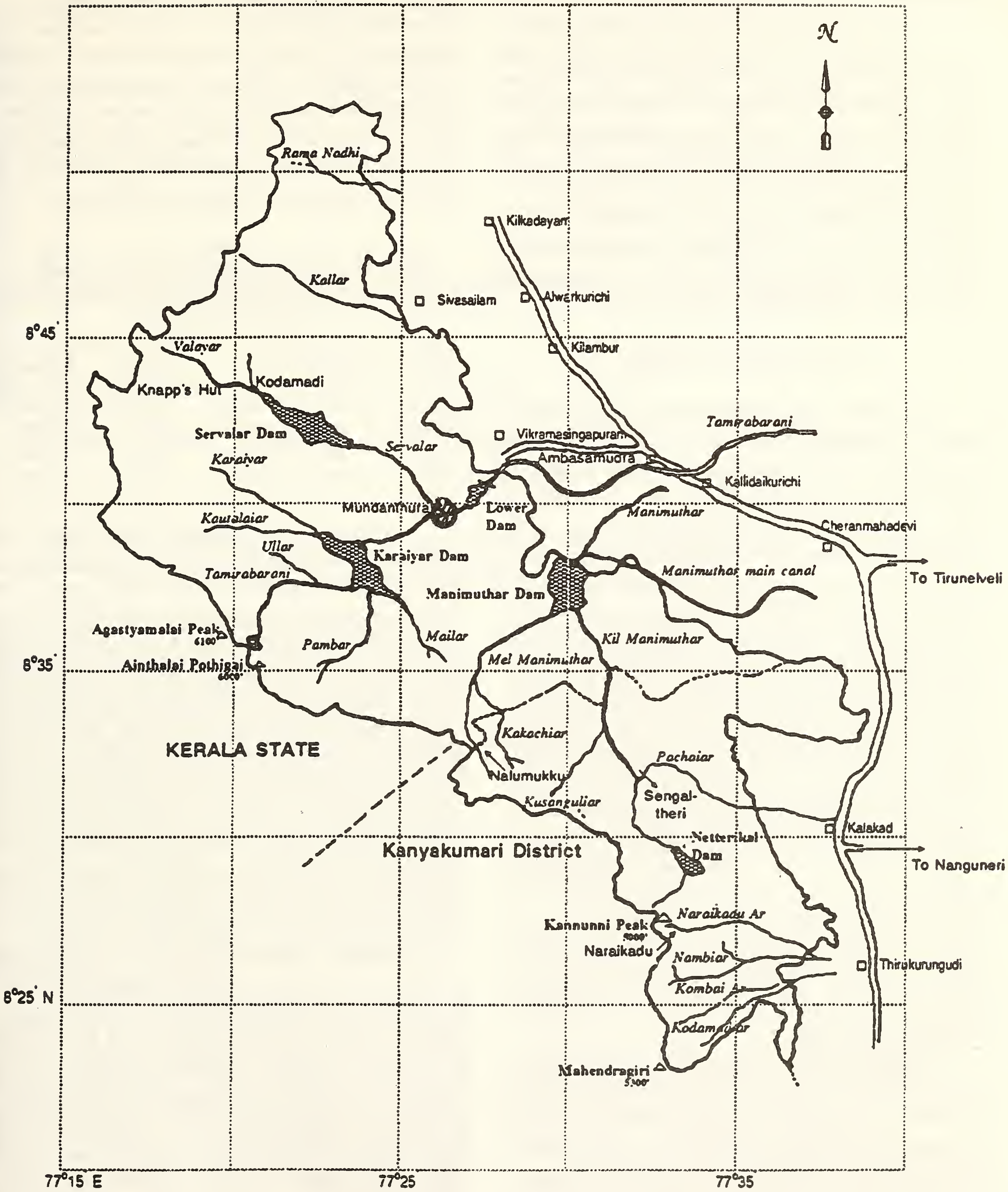
N
Rama Nadhi
Kilkadeyam
Kallar
Sivasailam
Alwarkurichi
8°45'
Valayar
Kilambur
Knapp's Hut
Kodamadi
Servalar Dam
Servalar
Vikramasingapuram
Tamirabarani
Karaiyar
Ambasamudra
Kallidaikurichi
Mundanthurai
Lower Dam
Kautalaiar
Manimuthar
Cheranmahadevi
Ullar
Karaiyar Dam
To Tirunelveli
Tamirabarani
Manimuthar main canal
Manimuthar Dam
Agastyamalai Peak 6100'
Pambar
Mailar
Kil Manimuthar
8°35'
Ainthalai Pothigai 6000'
Mel Manimuthar
Kakachiar
KERALA STATE
Pachaiar
Nalumukku
Sengaltheri
Kusanguliar
Kalakad
Netterikal Dam
Kanyakumari District
To Nanguneri
Kannunni Peak 5000'
Naraikadu Ar
Naraikadu
Nambiar
Thirukurungudi
8°25' N
Kombai Ar
Kodamadiar
Mahendragiri 5300'
77°15 E
77°25
77°35

Fig. 2. Location of study area in Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu.

abundances, and discuss the significance of our results for conservation, both in India and globally.

P. nitidus is entirely insectivorous. Following the suggested outline of Grant and Boag (1980), we use a comparative study over four years to measure the strength of the causal links between rainfall and its effects on birds according to the scheme: Rainfall -> Primary production -> Arthropod abundance -> Warblers. We show the effect of rainfall on both warbler abundance and individual condition, and use these results and long-term rainfall records to infer a large effect of climate on population size.

Study Area and Methods

Location: The Kalakad-Mundanthurai Tiger Reserve (*c.* 830 sq. km, 8° 40 'N, 77° 20 'E) lies at the southern end of the Western Ghats mountain range of peninsular India (Fig. 2). We conducted this study on Mundanthurai plateau (*c.* 60 sq. km), located within the reserve (180-200 m above msl). The plateau, being in the rain shadow of the Southwest monsoon (June-August), receives most of its rainfall during the Northeast monsoon (October-December, Joshua and Johnsingh 1988). Two distinct vegetation types occur: evergreen riverain forests along the plateau's two perennial rivers, and dry deciduous forests elsewhere. In the 1960s parts of the dry forest were clear-cut for commercial plantations which were subsequently abandoned. As a result, the plateau now has a mosaic of primary and secondary vegetation. We established a 50 ha study area at the confluence of the Thambiraparani and Servalar rivers (Fig. 2) and focused mainly in this area for each of the four years (Table 1). Fifteen hectares of this study area was denoted the core and every tree was numbered, catalogued and mapped.

Climate, Plants and Insects: A daily record of rainfall and temperature was maintained at the site. We also obtained long-term rainfall data from the Tamil Nadu Electricity Board's weather station at Lower Papanasam Dam, *c.* 3 km from our study area (Fig. 2). One of us (M. Katti) also recorded plant phenology by estimating tree cover at 200 points along standard transects (Mueller-Dombois and Ellenberg 1974): at each point, we recorded vegetation if it blocked the vertical line of sight by looking straight up. We use the proportion of points with foliage (reported as a percentage) as a simple index of the amount of foliage in the canopy, and therefore, of primary production by the trees. We did this every year in January or February.

Table 1

PERIODS OF STUDY AND NETTING EFFORT AT MUNDANTHURAI DURING EACH OF FOUR WINTER SEASONS (1992-96)

Season	Study Period	Days	Net-hours
1992-93	Dec. 6 - Feb. 28	84	6,500
1993-94	Oct. 10 - Mar. 10	123	8,700
1994-95	Sept. 15 - May 10	237	22,900
1995-96	Dec. 5 - Jan. 15	41	6,400

To estimate Arthropod abundance we periodically sampled 35 of the most common trees and large shrub species in the study area in the following manner: we covered a small branch, up to 4 m high, with a large (*c.* 200 litres) polythene bag, broke off the branch, and dropped in a small piece of cotton soaked with chloroform. All Arthropods were carefully sorted a few hours later, and collected in alcohol for measurement and identification in the lab. They were subsequently classified into three size categories based on total body length: small 0-2 mm, medium 2-6 mm, large > 6 mm. These size categories correspond to the estimated sizes of prey observed being eaten by the warblers (see below; Price 1991). We collected 50 samples each year in January.

Warbler Captures: Between 10-50 mist-nets (7' x 42', 1.25" mesh size) were opened from dawn to dusk on 255 days over the four winter seasons. Nets were raised into the canopy, at 2-10 m above the ground, at a series of standard locations. At any particular location, a net was operated for a maximum of four days. In the core plot, we captured nearly all individuals (> 90% of those present). Individuals were ringed using a unique combination of one numbered aluminium ring from the Bombay Natural History Society and up to two colour rings. We

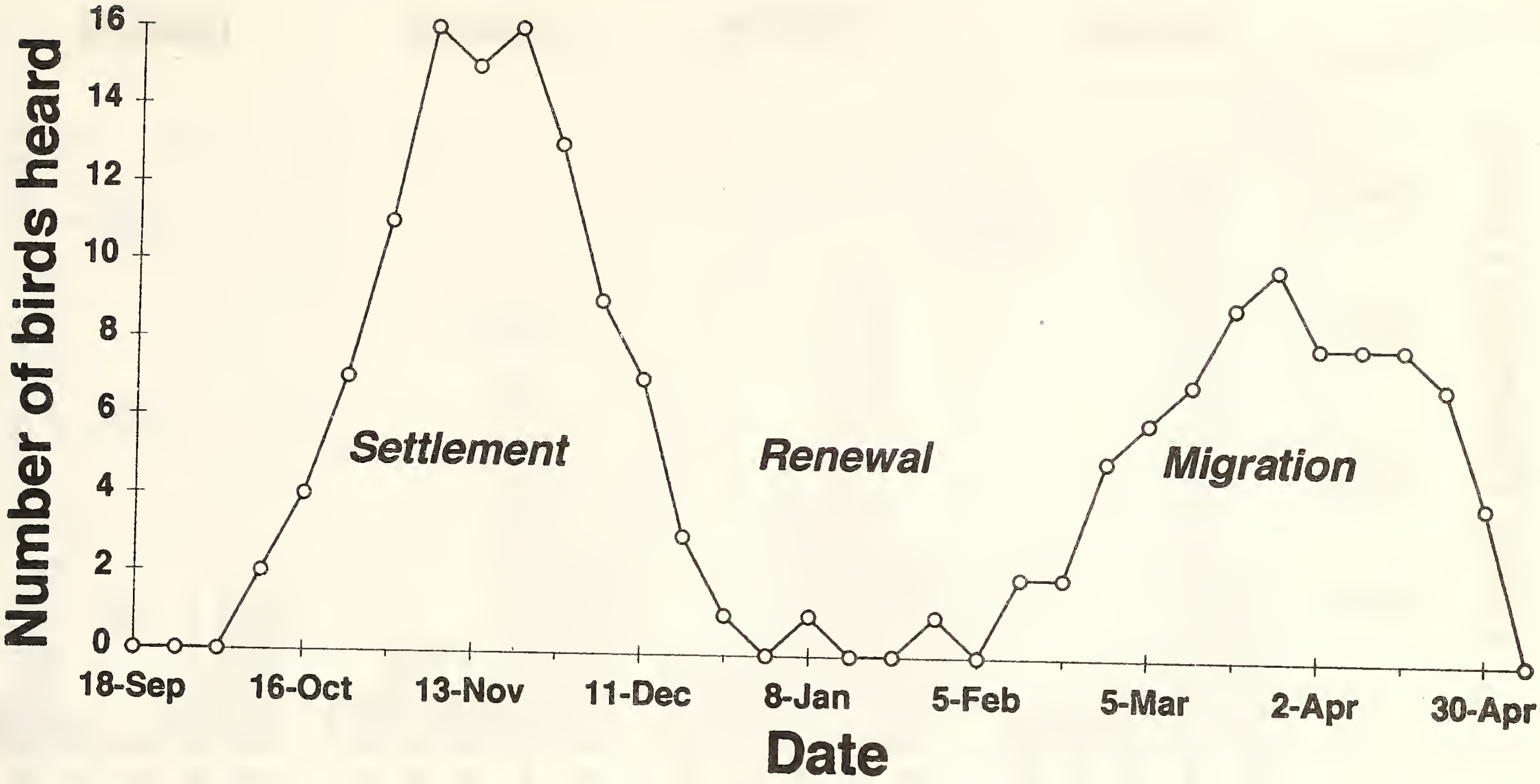

Fig. 3. The weekly frequency of singing Green Leaf Warblers, *P. nitidus* encountered on census walks at Mundanthurai, illustrating the three main life-history phases during winter. Data are from the 1994-95 season, for which we have complete coverage (see Table 1 for study dates).

weighed each individual and classified it into one of the two age categories - First Winter (FW) and After First Winter (AFW) - based on the extent of skull pneumatization (Svensson 1984, Ralph *et al.* 1993). We also recorded the status and extent of primary moult by ranking each of the primaries on each wing according to stage of development: 0 - old; 1 - missing or pin; 2 - grown to less than a third length; 3 - between a third and two-thirds grown; 4 - more than two-thirds grown; 5-full grown new (Ginn and Melville 1983). The individual scores for all the primaries were then added to get a single primary moult score for each bird.

Warbler Censusing: At least once every two weeks, in a three-hour period at dawn, we walked along marked trails through various parts of the study area to count warblers. The study area was split into four zones (two within the 15 ha core area marked and two outside) with each census walk covering one zone. During both census walks and many casual observations, every time a *P. nitidus* was heard calling, we attempted to locate and identify the individual (if it was colour-ringed), note its activity and mark its location on a map. We made a particular effort to locate instances of singing since that indicates territorial interaction (Price 1981). For each sighting we recorded the location, plant species in which the individual was seen, height above ground and activity of the individual. From this, we obtained territory maps of colour-ringed individuals. We used the number of territories per hectare as our estimate of population density.

Our estimate of bird survival within each winter season is based on resightings of colour-ringed individuals. We define persistence as the probability of an individual remaining present on the study plot through the winter. We measure it as the observed proportion of birds marked before moult (January) that remained on the plot till the start of return migration (March). We have this data only for two years - 1993-94 and 1994-95.

Warbler Behaviour: We recorded foraging and other behaviour in two ways. Individuals were observed until they made the first feeding movement:

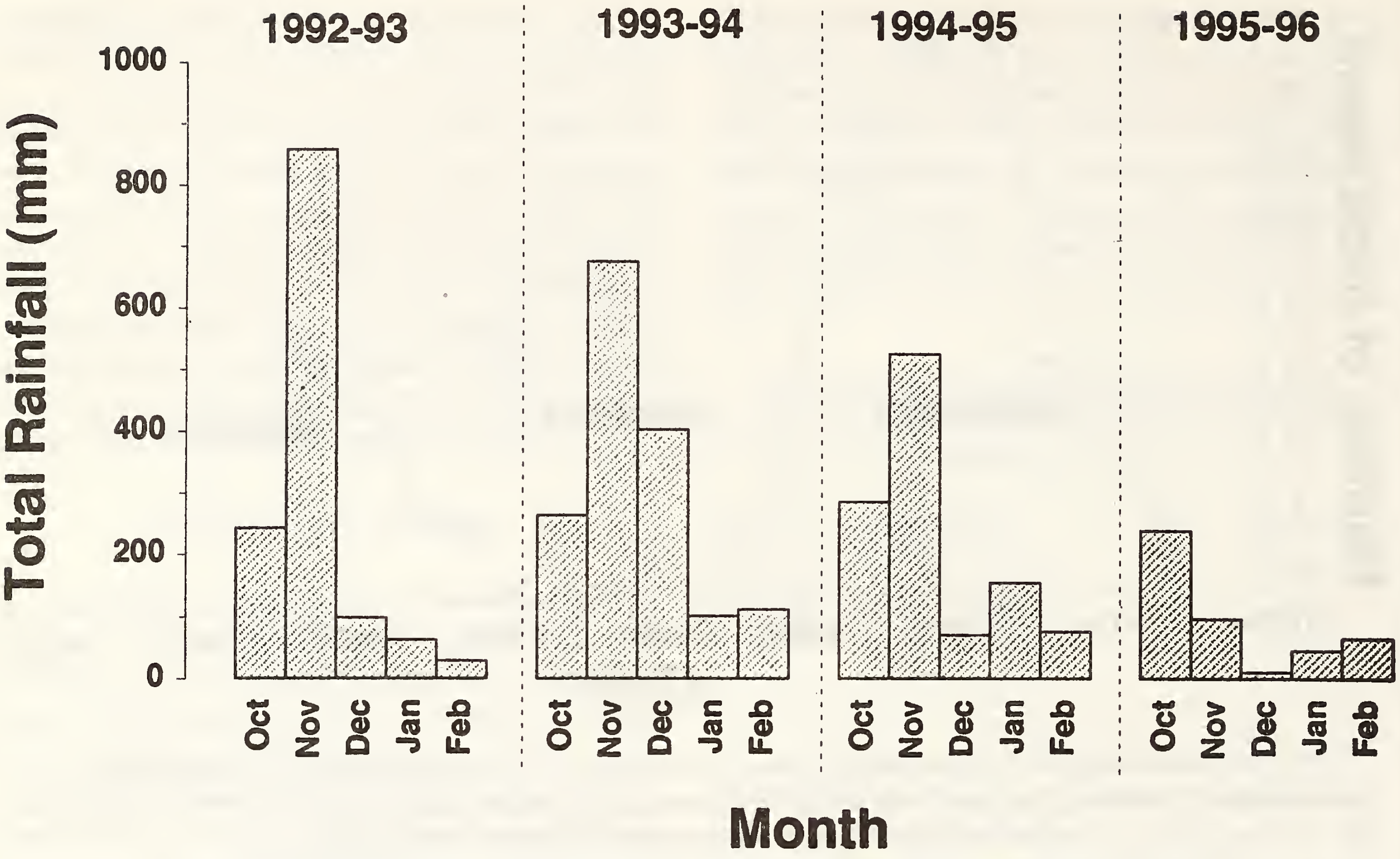

Fig. 4. Winter rainfall (mm) in Mundanthurai over the past four winters (1992-1996).

the type of movement, its location, and an estimate of prey size were recorded, following Price (1991). This method ensures independence of each observation. We use it to estimate the distribution of prey sizes eaten. Price (1991) showed a high correlation across species between this measure and prey size as measured from the faeces. In addition, we followed focal individuals for as long as possible (up to 30 minutes), recording all foraging attempts and other behaviour into a hand held tape recorder. This provided data on foraging rates.

RESULTS

Natural History: *P. nitidus* first arrives in northern India during August (Gaston 1981), and takes over a month to reach southern India. At Mundanthurai, arrival usually begins near the end of September, and continues through early December (Fig. 3). Individuals are solitary and territorial in the winter, with both sexes holding independent territories throughout the winter. In Mundanthurai, settlement usually begins along the riverain gallery forest, which is more evergreen, and has considerably more foliage in September (at the end of a long dry season, see below). Birds arriving later occupy areas of deciduous forest away from the river. All birds which return from previous years retain their old territories in both habitats (see also Price 1981). This suggests strong site fidelity as well as consistency in timing, for previous territory holders in the deciduous forests arrived later than those in the riverain forest.

In Mundanthurai, the *P. nitidus* population exhibits three distinct phases (illustrated in Fig. 3): The first phase, settlement, runs from late September to December, and comprises arrival, habitat selection and territory establishment. About 30% of birds caught during arrival underwent a partial moult of their primary coverts and some body feathers either during migration or immediately upon arrival. It is characterized by frequent interactions among

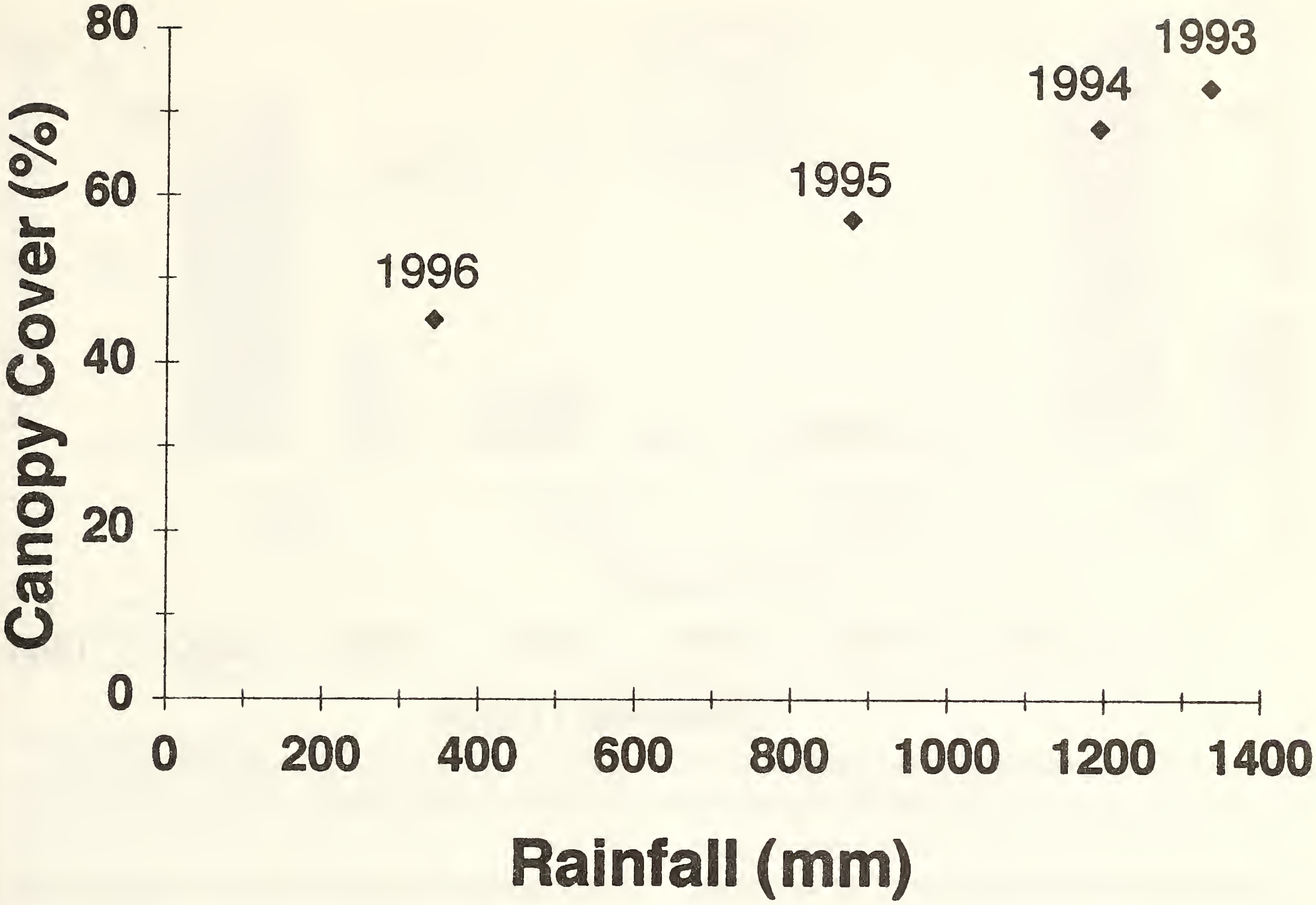

Fig. 5. The relationship between January canopy cover and October-December rainfall at Mundanthurai over four winters (1992-1996). Pearson's $r = 0.993$, $P < 0.05$.

individuals while territory boundaries are negotiated (Fig. 3). Territorial behaviour ranges from simple calling through intense face-to-face contests lasting several hours (apart from breaks during foraging bouts), and sometimes continuing over many weeks. During such interactions, birds chase each other, flick their wings and often sing continuously. Singing is seldom heard outside of such contests, and both sexes sing. Many individuals disappear (permanently) during this period, after failing to obtain territories.

The second phase, which we call the renewal phase, lasts from January to mid-March, when the birds undergo a complete moult. This is socially the quietest part of the season, with very little interaction among individuals, and rates of calling are at the lowest (Fig. 3). A moult of all feathers starts near the end of the Northeast monsoon in January and lasts through February, often extending into late March. During moult, most individuals drop most of their flight feathers at once and become virtually flightless for up to two weeks.

The final phase, migration, begins soon after the end of moult, by mid-March, and lasts until late April when all the birds disappear. During this phase foraging rates increase as individuals start accumulating fat in preparation for the return migration. Some migrating birds, presumably from more southern areas, pass through Mundanthurai, mainly along the rivers, and there is an increase in the rates of vocalization and interaction.

While the population conforms to the above pattern of life-history during each winter, we found considerable year-to-year variation in measures of individual condition, and in population parameters. Much of this variation appears to be driven by fluctuations in winter rainfall, and associated changes

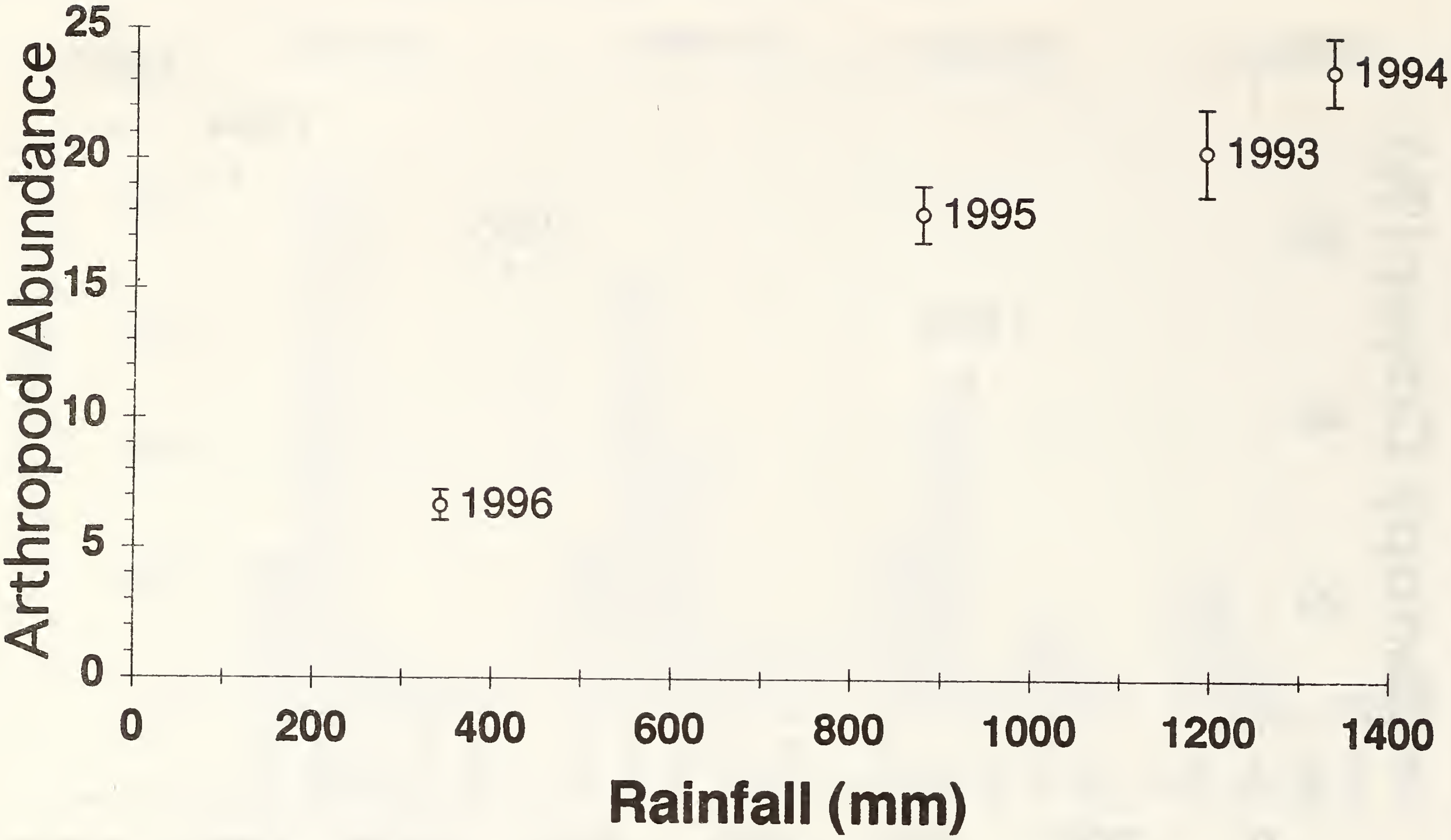

Fig. 6. The relationship between January arthropod abundance (x ± S.E.) and October-December rainfall at Mundanthurai over four winters, Pearson's r = 0.986, $P < 0.05$.

in tree canopy cover and Arthropod prey abundance. We describe the trends in each of these variables below and look at their relationship to warbler abundance and individual condition.

Rainfall: During the study, Mundanthurai experienced three-fold variation in winter (October-February) rainfall, with high rainfall in the first two winters, to near-drought in 1995-1996 (Fig. 4). The fluctuation is similar to that in the past (1960-1985, Fig. 11), though the first two years (1992 and 1993) were wetter than any between 1960-1985.

Plant Phenology: Mundanthurai, which is in the rain shadow for the Southwest monsoon, experiences a long dry season between March and September, when most of the plateau's forest is leafless, except some evergreen species along the rivers. The main leaf flush, and season of primary productivity, starts with the Northeast monsoon, arriving usually in November. Our estimate of tree canopy cover in Jan./Feb. (at the end of the monsoon growing season) should therefore be an estimate of leaf cover at its peak. The estimate varied considerably across years (Coefficient of Variation = 20.5%, N = 4) and showed a strong positive correlation with October-December rainfall (Fig. 5, Pearson's r = 0.99, $P < 0.05$, N = 4).

Arthropods: Arthropod abundance follows the first leaf flush in late November (M. Katti and T. Price, unpublished data). Our estimate of total Arthropod abundance, also measured in January, near the end of the growing season, was strongly positively correlated with October-December rainfall (Fig. 6, Pearson's r = 0.99, $P < 0.05$, N = 4), and with canopy cover (Pearson's r = 0.96, $P < 0.05$, N = 4). In the driest year, total Arthropod abundance was 28% of that in the wettest year. Similarly, large prey in the driest year was 29% of that in the wettest year comparison, and Arthropod abundance showed a parallel trend in all three size categories (Fig. 7).

Warbler Density: As described earlier, the early arriving warblers of October occupy the semi-

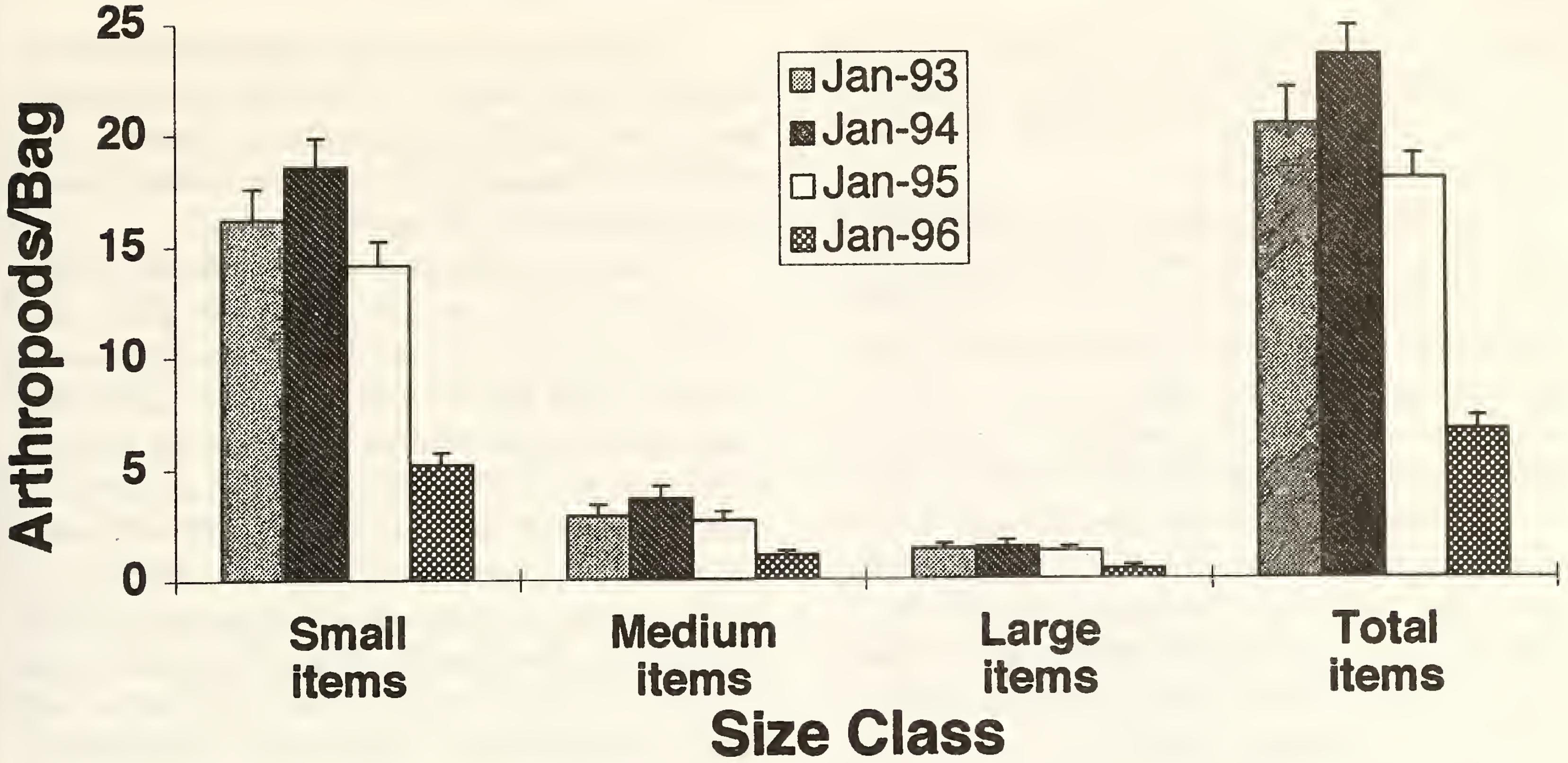

Fig. 7. Arthropod abundance in different size categories across four winters (in January) at Mundanthurai. Histogram shows mean ± S.E. Small items: < 2 mm; Medium items: 2-6 mm; Large items: > 6 mm.

evergreen riparian forests, while the additional arrivals almost coincide with the onset of the monsoon. The Blyth's Reed Warbler, *Acrocephalus dumetorum*, which is known to stop in north India for a complete moult (Gaston 1976), also arrives in Mundanthurai with the Northeast monsoon. Gaston (1981) reported that some Greenish Warblers, *P. trochiloides*, lingered in his study area in Delhi for a few days during passage, before disappearing. We speculate that individuals arriving late in Mundanthurai stop at other locations enroute, possibly tracking local resource abundances (like some African wintering species, Marchant 1992, Hedenström *et al.* 1993). Arrivals peak during early December and densities stabilize by the end of December, once territories have been established. The number of territories on the core plot during our study differed between the four years (Table 2). Density in January 1996 (1.9 birds/ha) was about 60% of that in January 1993 (3.2 birds/ha). A similar trend is apparent in a comparison of mist-net capture rates for *P. nitidus* over four years (Fig. 8) - note that there is considerable variation in capture rate within each season; the appropriate comparison is for each month between years, which shows the declining trend.

Persistence: Persistence was studied to assess the trends in disappearances during the settlement phase. We were able to cover the entire winter season, from settlement through spring migration, and estimate persistence, for only two years (1993-94 and 1994-95). Comparing the fate of birds captured during October 15-December 31 in these two years, we found an almost two-fold difference in persistence (Fig. 9, X^2 test, $P < 0.01$). The trend is the same as that in density – the drier year (1994-95) had lower persistence than the wetter year (1993-94).

Effects on Individuals: We have shown a correlation between environment and population density. Such environmental influences may also affect the fitness of surviving individuals, since body condition at the end of winter is likely to influence the ability to migrate and breed successfully. Price (1981) found that during the dry season in the Eastern Ghats (which is in the middle of the winter there) mean body weight of Greenish Warblers, *P. trochiloides*, decreased. This was also the time when birds with small territories disappeared (which was equated with death, Price 1981). We compared morphological and behavioural traits of persisting birds during December-January over four winters to assess effects of the different climatic conditions at individual level. We found significant variation in several of them (Table 2).

The mean body weight of the Mundanthurai population during December-January (just prior to moult) varied significantly over four winters (Table 2), and showed a positive correlation with October-December rainfall (Pearson's $r = 0.92$, $P < 0.05$), canopy cover (Pearson's $r = 0.96$, $P < 0.05$) and Arthropod abundance (Pearson's $r = 0.87$, $P < 0.05$).

To better understand this change in body weight in terms of individual behaviour, we looked at foraging behaviour. Mean prey capture rate in December-January did not differ between the years. The proportion of small prey captured, however, showed a non-significant increase. An increase in the proportion of small items might be expected with a decrease in the availability of food (Fig. 7), and if real, suggests a lower Arthropod biomass intake in the drier years.

While food availability in January might affect the immediate probability of survival, its apparent effects on body condition could also have repercussions on migrating ability and breeding success. This is illustrated through our comparative study of primary moult over four years. We found that the onset of primary moult — estimated as the x-intercept of the regression of primary moult on date — was delayed during years of low rainfall (Fig. 10). Since studies in the breeding season have found late-arriving birds to have lower breeding success (Price *et al.* 1988, Price and Jamdar 1990), we predict lower breeding success in the summers following the drier winters.

We can now hypothesize causal links between rainfall, canopy cover, arthropod abundance and warbler abundance. All of these variables are strongly and significantly, correlated (Table 3). The hypothetical causal pathway underlying these correlations may be illustrated as follows (with the correlation values shown above each path):

$$\text{Rainfall} \xrightarrow{r = 0.993} \begin{array}{c}\text{Canopy}\\ \text{Cover}\end{array} \xrightarrow{r = 0.962} \begin{array}{c}\text{Arthropod}\\ \text{Abundance}\end{array} \xrightarrow{r = 0.97} \begin{array}{c}\text{Warbler}\\ \text{Density}\end{array}$$

Such strong correlations suggest that variation in rainfall over a longer term than this study should have a strong effect on population trends in the warblers. To assess this we examine available long-term rainfall data from recent decades.

Long-term Patterns in Rainfall: According to rainfall records over 26 years (1960-1985; Fig. 11), winter rainfall fluctuated substantially, between 26.9 and 1025 mm (x = 512.1 ± 326.3 S.D.). By comparison, higher rainfall was recorded in 1992 (1195 mm) and 1993 (1338 mm) than in any previous year, but the drier years of 1994-95 were well above the minimum experienced. A 75% decrease in rainfall during our study was accompanied by a 40% decline in warbler density. Extrapolating this to the long-term rainfall variation, we predict that bird density also fluctuates in response to winter rainfall.

Climatic factors such as rainfall variation are likely to have general effects on all bird species in

TABLE 2

SOME CHARACTERISTICS OF THE GREEN LEAF WARBLER *Phylloscopus nitidus* ON MUNDANTHURAI PLATEAU OVER FOUR WINTERS (1992-96)

	1992-93	1993-94	1994-95	1995-96
Body Weight[1]	7.6 ± 0.1	7.7 ± 0.1	7.5 ± 0.1	7.3 ± 0.1
Onset of Moult[2]	Jan.-9	Jan.-5	Jan.-23	>Jan.-15
Prey Capture Rate[3] (per min., Dec./Jan.)	0.7 ± 0.2	0.7 ± 0.1	0.8 ± 0.2	0.6 ± 0.4
Proportion of small items in prey (%)[4]	80	83	86	91
Density[5] (territories/ha)	3.2	3.1	2.8	1.9

1. $\bar{x}$ ± s.e., n = 12 (1992-93), 20 (1993-94), 17 (1994-95), 11 (1995-96), ANOVA, F-ratio = 3.9, $P < 0.05$.
2. Onset of moult is estimated from regression of primary moult score on date.
3. $\bar{x}$ ± s.e., n (minutes) = 35 (1992-93); 41 (1993-94); 50 (1994-95); 38 (1995-96).
4. From point observations of foraging; n = 56 (1992-93); 100 (1993-94); 112 (1994-95); 86 (1995-96).
5. From territories mapped on 15 ha core plot.

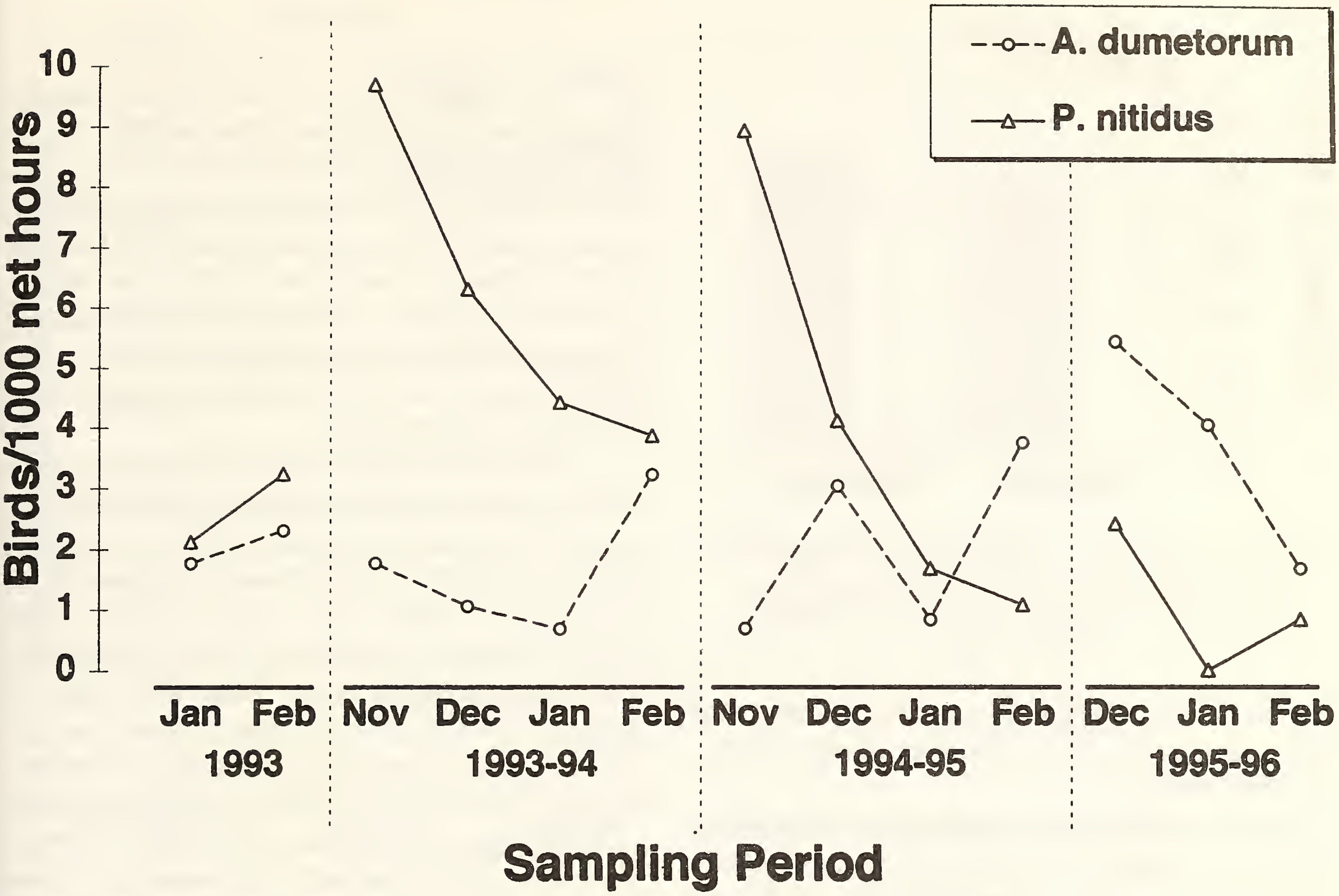

Fig.8. Monthly capture rates (birds per 1000 net-hours) for Green Leaf Warbler, *Phylloscopus nitidus* and Blyth's Reed Warbler, *Acrocephalus dumetorum* at Mundanthurai during four winters (1992-1996).

TABLE 3
MATRIX OF CORRELATIONS BETWEEN RAINFALL, CANOPY COVER, ARTHROPOD ABUNDANCE AND WARBLER DENSITY OF MUNDANTHURAI, USING DATA FROM FOUR YEARS (1992-96). ALL VALUES ARE PEARSON'S 'r'

	Rainfall October-December	Canopy Cover (%)	Arthropod Abundance
Canopy Cover (%)	0.993	—	—
Arthropod Abundance	0.986	0.962	—
Green Leaf Warblers (territories per ha)	0.969	0.939	0.970

an area. Having elaborated on one species in detail, we now look at our (less intensive) data on other migrant warblers wintering in Mundanthurai, and find parallel trends.

Other species: *P. nitidus* dominates the guild of foliage-gleaning insectivores in the forest canopy, and is perhaps the only one to maintain an entirely insectivorous diet through the winter. Other resident sympatric canopy foliage-gleaners include the Iora, *Aegithina tiphia*, which also feeds on fruit and nectar, Sunbirds (two species of *Nectarinia*) and Flowerpeckers (two species of *Dicaeum*) which are partial nectar-feeders and Minivets (two species of *Pericrocotus*) which are not very common. We did not measure the abundance of these species. The most common insectivore in the forest understory is another Palearctic migrant Sylviid warbler, the Blyth's Reed Warbler *Acrocephalus dumetorum*, which also overlaps with *P. nitidus* in their breeding range. A third common migrant warbler is the Himalayan breeding Large-billed Leaf Warbler

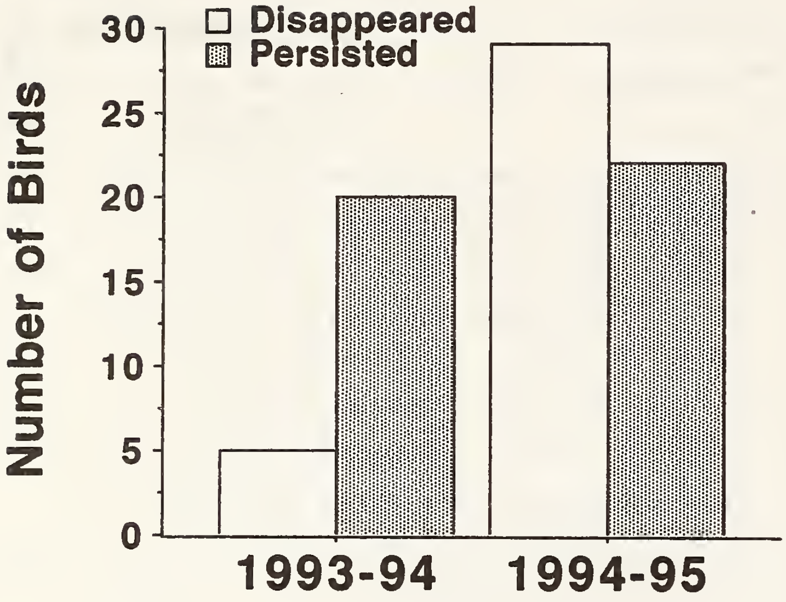

Fig. 9. Comparison of within-season persistence of colour-ringed Green Leaf Warblers, *P. nitidus*, in Mundanthurai between 1993-94 and 1994-95. X^2 test, $P < 0.01$.

Phylloscopus magnirostris, which occupies riparian and more evergreen forests and also forages mostly in the understory.

We monitored both these migrant warblers (in addition to *P. nitidus*) during the census walks as well as during mist-netting. *P. magnirostris,* of which we mapped territories also, shows similar trends as *P. nitidus* in density; the riverain stretches of the study plot (< 2 ha) had 5 territories in 1992-93 and 1993-94, 3 territories in 1994-95 and 2 territories in 1995-96. *A. dumetorum* is harder to observe due to its preference for foraging in the interior of dense bushes, so we were not able to identify individuals for accurate territory mapping. The mist-netting data, however, show an interesting trend (Fig. 8): *A. dumetorum* capture rates tend to be negatively correlated with *P. nitidus* capture rates (r = 0.47, N = 4, not significant), and more *A. dumetorum* were caught in the driest year than in other years. Since the nets are placed up in the canopy, mostly above the foraging range of *A. dumetorum,* these capture rate data may be interpreted as an index of the relative frequency of canopy foraging by *A. dumetorum.* Thus we do not attribute the change in capture rate to change in densities, but rather to change in foraging in response to low food availability (see also Price 1981).

DISCUSSION

A striking result of this study is that changes in rainfall and prey abundance affect warbler density and condition within a relatively short period, just over two months after the initial arrival of warblers in each season. The settlement period from October to December is thus most critical for winter population dynamics, if these months are relatively dry, the resulting low prey abundance reduces mean body weight and causes more birds to disappear, even before the onset of moult.

While some birds undoubtedly move to other areas, we believe that the differences over different years is attributable to mortality for the following three reasons. First, winter habitat is saturated and probably the main factor limiting populations because of intense competition for territories during the settlement phase (Price 1981, this study, R. Kannan, pers. comm.). By contrast, there are very low densities (< 1 bird per sq. km) in some northern breeding areas, such as Siberia, where apparently suitable patches of forest are often empty (T. Price, pers. observation). Second, Mundanthurai is close to the species' southern range limit within peninsular India, and arrival here is also fairly late (more than two months after birds start leaving the breeding area: Cramp 1992). Birds failing to obtain territories here do not have much space, time, or energy reserves (arriving birds have virtually no visible subcutaneous fat left; M. Katti, unpublished data) to explore other areas. Finally, rainfall across the eastern half of peninsular India is largely under the influence of the Northeast monsoon currents and a lower amount of winter rainfall in Mundanthurai represents general failure of the monsoon. Any dispersing warblers are thus unlikely to find conditions different from Mundanthurai elsewhere during dry years.

We have shown that the reduction in prey abundance in dry years correlates with lower densities and also with lower body weight by January, indicating that surviving birds are in poorer physiological condition. An immediate consequence of this is on the timing of moult. It is known that moult — particularly of flight feathers — is

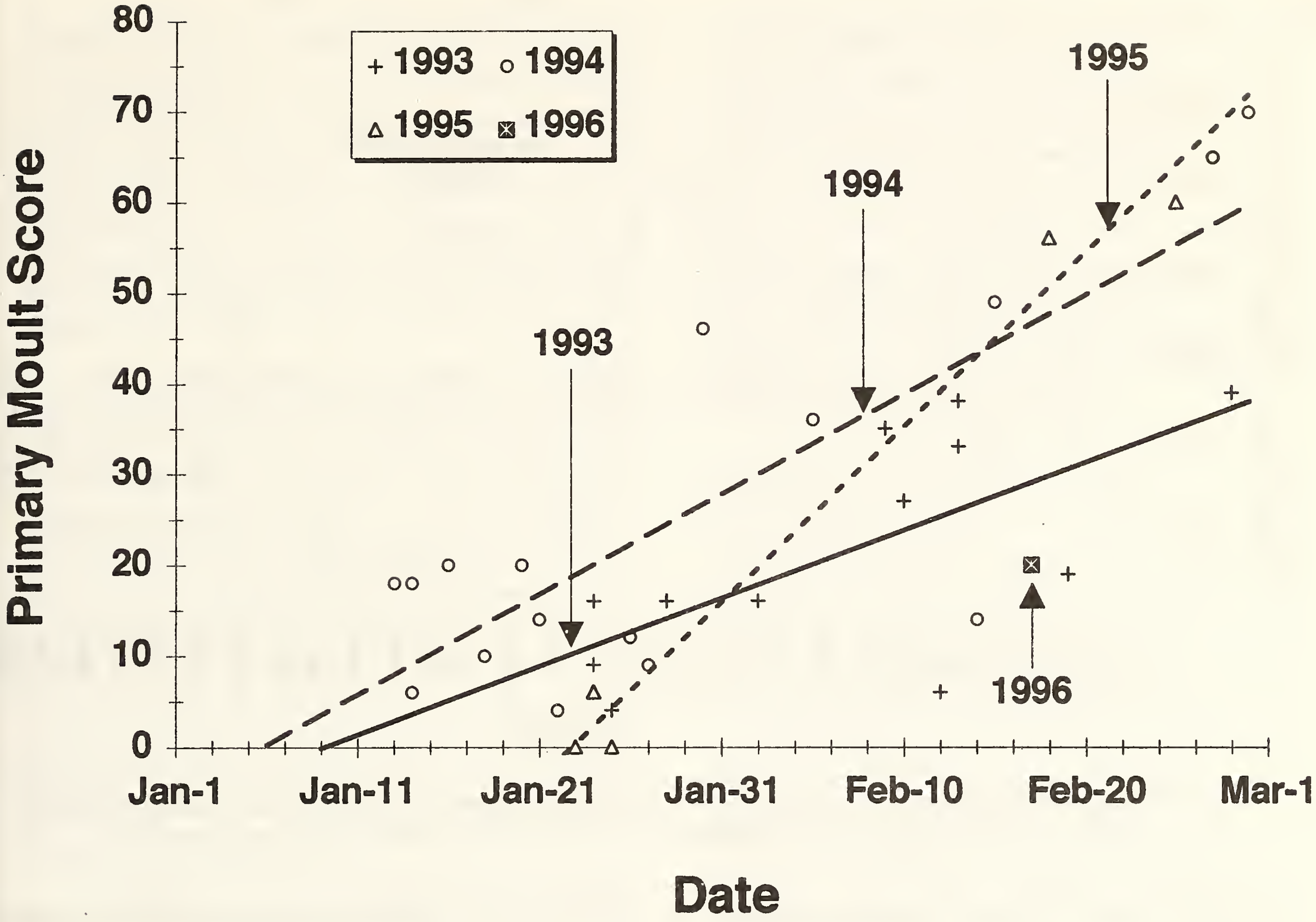

Fig. 10. The relationship between primary moult score and date for the Green Leaf Warbler, *P. nitidus*, at Mundanthurai, 1994-1996. Only one bird was captured during moult in 1996. Regression, $P < 0.05$ for all three years 1993, 1994, 1995; ANCOVA, Moult vs. Date, Year: whole model, F-ratio = 16.42, $P < 0.01$; date(*) year interaction, F-ratio = 3.95, $P < 0.05$.

physiologically stressful and increases the risk of predation as birds lose their flight efficiency (Bensch *et al.* 1991, Gosler 1991, Lindström *et al.* 1993). At the same time, every bird must complete its moult in order to be able to fly back to the breeding grounds. An individual that does not have sufficient resources for moult may not be able to return to the breeding grounds at all. Individuals appear to be also under a time constrain, since early breeding individuals typically fledge more young than later ones in many species (Price and Jamdar 1990). Delayed moult can thus directly result in reduced breeding opportunity.

Our results imply that population size in January can be perfectly predicted from rainfall over the preceding three months. This means that the population is entirely regulated during the winter season, and that breeding and migration have no influence. Limited data on other species shows that their densities (*Phylloscopus magnirostris*) and behaviour (*Acrocephalus dumetorum*) are also affected by dry years, and the influence of climate on population size is likely to be generally strong. Conclusions need to be tempered by the short duration of this study (4 years), and it is possible that in other years breeding and migration success have more influence. In addition, we have not observed the full range of climatic extremes which have been recorded in the winter season (Fig. 11), and the relationship between climate and population size may not be as strong when very dry years are

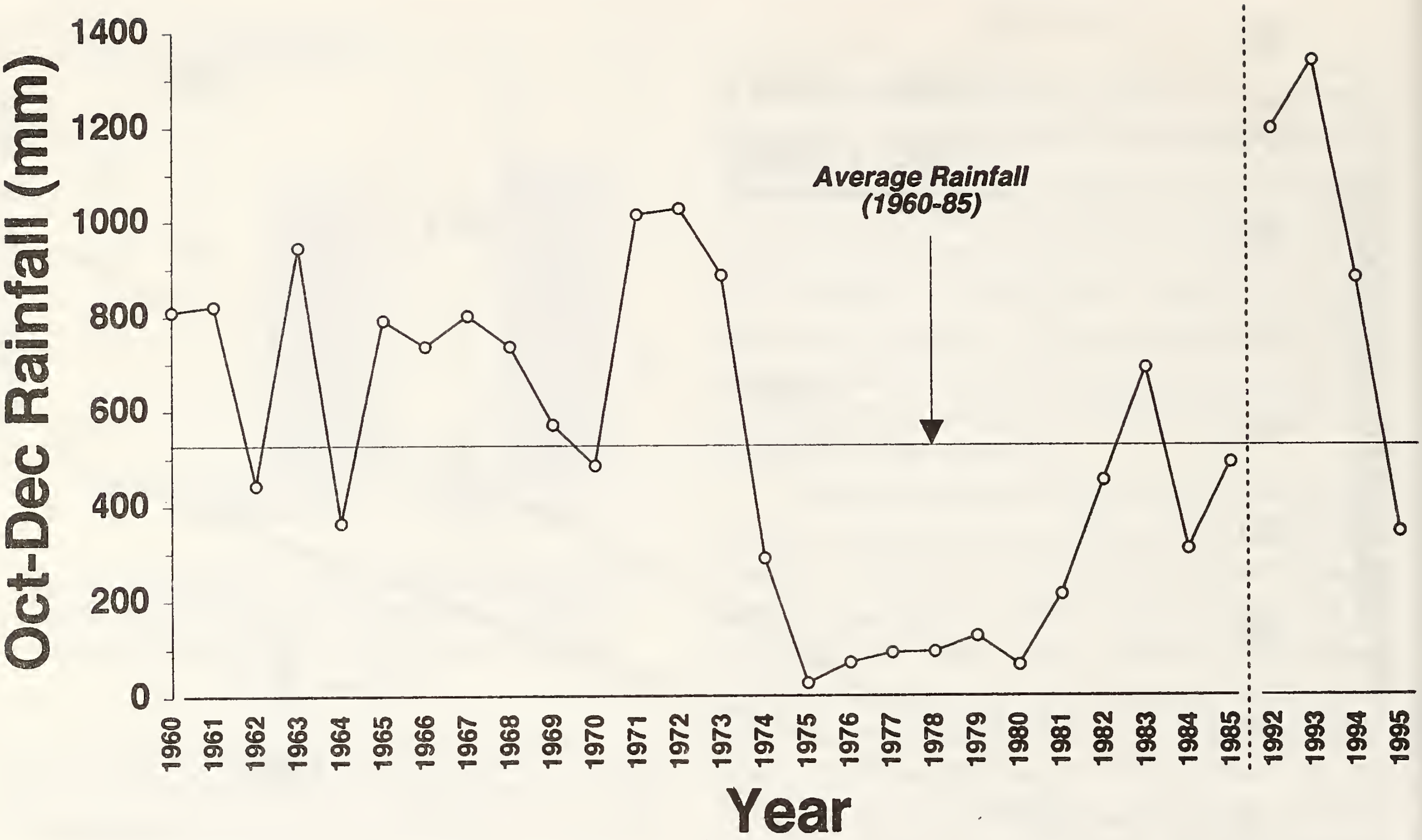

Fig. 11. Winter rainfall (October-December totals) on Mundanthurai plateau during 1960-1985 (data from Tamil Nadu Electricity Board, Lower Papanasam Dam) and 1992-96 (this study, Mundanthurai).

included (although we have no reason to believe that it is not).

Even if there is strong population regulation in the winter, there can be effects of breeding success on local populations. If breeding habitat is unsaturated, then breeding failure in any one locality may result in fewer birds returning to that locality the following year, with possible compensatory increase elsewhere. Several studies in North America (e.g. Holmes *et al.* 1991, Holmes and Sherry 1992) have shown that breeding success does affect recruitment to the populations of the migrant warblers they studied, but possible compensatory effects on populations elsewhere have not been assessed. A second explanation for studies which find an importance of breeding success for migrant species in America and Europe (Böhning-Gaese 1992, Böhning-Gaese *et al.* 1993) is that winter regulation of populations in the Americas and Africa may be less strong than it appears to be in India, because the area of habitat available for over-wintering warblers is probably much less in India. This is especially plausible when viewed in terms of the spatial extent of the breeding areas which are supplying winter migrants. India accommodates many warbler species which breed from the Himalayas north throughout central Siberia and west to Europe.

The Americas and the Europe/Africa migration systems may be different from Asia because of differences in geography, but it is from those systems that most of the data on migrants come (e.g. Fig. 1). The data show both declines and increases of populations at average rates of up to 7% annually, over periods of more than 20 years. Populations have thus changed as much as five-fold over the duration of these studies. We have detected a population decrease of 40% due to climatic change in our four year study, but have not studied very dry years. Thus, it is at least possible that some of the changes in population size of other species are attributable to climate changes, and climate needs to be factored in before more direct human influences on population size are addressed. Our results point to potentially major effects of human-induced climatic changes, such as global warming, on population sizes of different species. They are consistent with the findings of Burton (1995) who has attributed many changes in geographical distribution to recent climate change.

Our study measures the extent to which populations within a single locality are changing, and does not produce an estimate of change in the total numbers of this species. If the inference that habitats are saturated in the winter is correct, then the population size of the species as a whole is likely to be affected by habitat destruction in the wintering range. Few studies have addressed the extent to which population sizes are declining. Perhaps the closest are the breeding bird surveys in North America, which have taken place along the same prescribed routes over many years (e.g. James *et al.* 1996), and show both declines and increases over the past 20-30 years (Fig. 1).

In general, changes in population size depend on the time-scale studied: 10,000 years ago, during the last major ice age, breeding habitat may have been limiting and perhaps the global population was low. We expect the population to have increased since then. The first waves of human-induced habitat change in India occurred a few thousand years ago (Gadgil and Guha 1992), with deforestation accelerating over the past several hundred years (Gadgil 1990, Gadgil and Guha 1992). The subsequent loss of winter habitat may have led to declines over the past few millennia. Habitat destruction has become rampant in recent decades (Rodgers and Panwar 1988, Gadgil 1990, Gadgil and Guha 1992), and its effect on local bird abundance and diversity has been reported (Daniels *et al.* 1990, Price 1990, ICBP 1992).

Extrapolating our four-year study to longer periods based on climate records entails making many assumptions, but can be used to provide a first approximation of the way in which populations have fluctuated in the recent past. We suggest that drought years (especially between 1975 and 1980) must have had dramatic effects on population size. If habitat is further reduced, we may be lulled into a false sense of security by the finding of within-habitat densities, for a single dry year may dramatically alter the picture, and drive populations close to extinction. While this may be a long way off for *P. nitidus,* which is one of the commonest birds in India and a good disperser between patches, the general principles are the same for those less common, poorly dispersing species which are more at risk.

In his later years Sálim Ali became increasingly concerned about habitat conservation. This differed from most other conservation biologists, who then focused mainly on charismatic endangered species, mostly large mammals. In this, as in many other ways, he was ahead of his time, for we now see conservation organizations throughout the world emphasizing environments and not species. In 1979, Sálim Ali discussed the important role insectivorous birds play in the ecosystem, based on studies of the Arthropod pests they consume (Ali 1979). We suspect he was ahead of his time here as well, and suggest that population studies of the commoner elements of India's fauna and flora will play a growing role in habitat conservation. They will provide the litmus test monitoring the state of the environment. We think this is one of many areas of research Sálim Ali would have been actively encouraging, and probably still doing himself, as he entered his second century.

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INTERACTIONS BETWEEN FRUIT-EATING BIRDS AND BIRD-DISPERSED PLANTS IN THE TROPICAL DRY EVERGREEN FOREST OF POINT CALIMERE, SOUTH INDIA

P. Balasubramanian[1]

(*With three text-figures*)

This paper examines interactions between 64 fleshy-fruited plants and 20 fruit-eating birds in a tropical dry evergreen forest at Point Calimere Wildlife Sanctuary, India. Seasonal patterns of frugivore availability, fruiting phenology, fruit colour, fruit size and gape width of frugivorous birds were studied and compared. The timing of fruiting and frugivore abundance were significantly correlated. There was a peak in the number of plants in ripe fruits during post-monsoon when there was a peak in the frugivorous bird population. Fruiting decreased during summer and pre-monsoon and the frugivorous bird abundance was low in this period. Species such as *Walsura trifolia, Azadirachta indica, Lannea coromandelica, Crateva adansonii* that fruited during summer were found to be keystone food resources for fruit-eating birds. Most bird-dispersed fruits appear red or black (to human eyes). Yellow, blue, white, green and orange are the other bird-fruit colours, but are uncommon. The colour spectra of bird-dispersed fruits at Point Calimere correlated with other regions of the tropics. The gape width of birds and the number of fruit species eaten by frugivorous birds were not correlated. Birds ate fruits irrespective of their sizes. For those plants which possess fruits with smaller seeds, birds are suitable dispersers. In the case of large-seeded fruits, birds ate only the pulp and seeds were dropped. For these plant species, mammals (e.g. *Cynopterus sphinx* and *Canis aureus*) are the suitable dispersers.

INTRODUCTION

The study of relationships between bird-dispersed plants and fruit-eating birds in tropical region has received considerable attention (Ali 1931, Howe and Estabrook 1977, Frost 1980, Beehler 1983, Wheelwright *et al.* 1984, Gautier-Hion *et al.* 1985, Lambert 1989, Dowsett-Lemaire 1988, Green 1993). While certain studies were focused on the interactions between the timing of fruiting of bird-dispersed plants and the abundance of fruit-eating birds (e.g. Smythe 1970, Wheelwright 1985a, Leighton and Leighton 1983 and Levey 1988), other studies were focused on the fruit colour spectra of fleshy-fruited plants consumed by birds (e.g. Turcek 1963, Janson 1983, Willson and Thompson 1982, and Wheelwright and Janson 1985) and the relationship between the fruit size and gape width of fruit-eating birds (e.g. Pratt and Stiles 1985, Wheelwright 1985b, Willson *et al.* 1989).

The relationship between the timing of fruiting of bird-dispersed plants and fruit-eating bird abundance is basic to understanding the tropical bird-fruit dispersal syndromes. Temporal variation in tropical fruit-eating bird abundance is usually ascribed to changes in fruit abundance (Skutch 1967, Morton 1973, 1977; Karr *et al.* 1982).

As fruit production fluctuates in many tropical forests, certain species fruiting during periods of fruit scarcity might assume importance as " Keystone resources" (Terborgh 1986). Information on animal responses to resource availability and identifying certain species which play a dominant role in mutualistic interactions in the community are important in the conservation and management of natural habitats.

In bird-dispersed plants, fruit colour is one of the many factors determining fruit choice by birds in the wild (Wheelwright and Janson 1985). Ridley (1936) noted that fruit colours are a form of long distance advertisement to fruit foragers. He observed that red and\or black are the most common colours of bird-dispersed fruits. Subsequent surveys by various authors have supported his generalization for particular floras.

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In fleshy-fruited plants, fruit size helps and constrains seed dispersal by animals. In tropical communities, it has been observed that small fruits attract a wider array of dispersal agents than larger ones. Plant species with small fruits are often visited by more species of dispersal agents (Snow 1971, Martin 1985, Howe and Westley 1988 and Dowsett-Lemaire 1988).

With this background, a study on the interrelationships between fleshy-fruited plants and their vertebrate consumers was conducted from May 1986 to December 1988 in the dry evergreen forest in Point Calimere, South India from where similar studies have not been carried out so far. The objectives of the study were: 1. to find out the relationship between the timing of fruiting of bird-dispersed plants and fruit-eating bird abundance, 2. colour spectra of fleshy fruits eaten by birds and 3. relationship between fruit size and gape width size of frugivorous birds.

STUDY AREA AND METHODS

The study area, Point Calimere Wildlife Sanctuary (10°18' N, 79° 51' E) is situated at a low promontory on the Coromandel Coast in the Tamil Nadu state of India. The Sanctuary spreads out in an area of 2401.38 hectares. The Jaffna peninsula of Sri Lanka is about 50 km away across the Palk Strait. The elevation of the area is 4 metres above mean sea level at the highest point of the sanctuary.

The average rainfall of Point Calimere ranges from 1000-1500 mm (Meher-Homji 1984). The temperature ranges from 21.5°C (absolute minimum) during the least warm month, January to 35°C (absolute maximum) during the warmer months, April, May and June. The calendar year of this tropical region of southern India is divisible into the following four seasons based on rainfall. 1. Post-monsoon - January, February, March. 2. Summer-April, May, June. 3. Pre-monsoon-July, August, September. 4. Monsoon-October, November, December. The flora and the vegetation of the Sanctuary has been studied by Sebastine and Ellis (1967), and Blasco and Legris (1973). Balasubramanian (in press) gives a detailed account of the flora of this region. Champion and Seth (1968) classified the vegetation of this sanctuary under "Tropical dry evergreen forest" type. Wooded portion of the sanctuary is only 50% of the area; the rest is covered by shallow swamp and open grazing lands. About 140 species of passerine birds and 18 mammal species have been reported from Point Calimere (Rajan *et al.* in press).

The Plants: Phenological records were noted for tagged individuals along a four kilometre transect in the study area. Ten individuals of each species were selected. Phenological data were collected for 64 plant species that include 27 trees, 23 shrubs and 14 climbers. A total of 555 individuals were marked for the study. The phenological data on fruiting were collected once a fortnight from January 1987 to December 1988. The plants were observed through a pair of binoculars and the abundance of fruiting was noted. Three categories, namely 'none', 'few' and 'many' were employed to indicate abundance of ripe fruits. The details of methods followed are given elsewhere (Balasubramanian and Bole 1993b). Ten ripe fruits from five individuals of each of the bird-dispersed plant species were collected. The colour of the ripe fruits against their natural background was noted. The fruit colours were assigned into one of eight broad colour categories commonly employed by other researchers (Turcek 1963, Willson and Thompson 1982, Wheelwright and Janson 1985), namely black, blue, brown, red, green, yellow, orange and white. Fresh fruits were weighed and mean mass of each species was calculated. Fruit diameter was measured with Vernier calipers. The number of seeds in each fruit was counted. The length of each seed was measured.

The Birds: The abundance of the avian frugivores was estimated by a census from January 1987 to December 1988. Once in a fortnight a census walk was made along a four kilometre transect, where the plants for phenology studies had been marked. Birds seen and heard 50 metres on either side of the transect were recorded (Emlen 1971). The gape width (the distance between the commissural points) was measured with Vernier calipers from the specimens of Bombay Natural History Society's collection. Avian nomenclature follows Ali and Ripley (1983).

Fruit-eating birds were identified by extended watches on fruit-bearing plants. The methods followed for recording bird visitation to fruiting plants are after Howe and Steven 1979, Frost 1980, Cruz 1981, Kantak 1981, Beehler 1983. Observations were made between 0600 and 0900 hr in the morning, usually for a continuous duration of three hours. The fruit utilisation by various birds was documented by identifying birds making feeding visits on fruiting plants. The number of visits made by each bird species was recorded for every five minutes during the three hour observation.

RESULTS

Species Composition of Fleshy-fruited Plants: Out of 317 species of flowering plants in Point Calimere, 88 species have fleshy-fruits. Among these, 64 species that were eaten by birds were selected for the study. The remaining 24 species were not included in the study because (i) 10 plants were dispersed only by mammals; (ii) seven species were dispersed by water and (iii) the remaining seven species, though dispersed by birds occur either rarely in the study area or were annual climbers. The 64 species are in 53 genera belonging to 34 families. Families represented by most native genera with fleshy-fruits eaten by birds are Rubiaceae (4), Euphorbiaceae (4) and Cordiaceae (3).

Fruiting Phenology of Bird-dispersed plants: Fruiting at Point Calimere is seasonal; with a peak in winter (post-monsoon) and a trough in summer. Number of species with ripe fruits was lowest during June (summer) in both the years-1987, 1988 (Table 1). The number of species with fruits started to increase from October (monsoon) in the first year and in September (late pre-monsoon) in the second year. The peak in fruiting was attained during February (post-monsoon) in the first year (1987), during March (post-monsoon) in the second year (1988). There was no significant difference in the number of species in fruit between 1987 and 1988 (Wilcoxon's signed rank test, $p > 0.10$).

Salvadora persica produced sterile fruits, without seeds during February, March and April. During May, September and October it produced fertile fruits with seeds. The sterile fruit was a thin-skinned berry measuring 5 mm diameter. The fertile fruit measured 6.2 mm diameter with a seed of 3.5 mm diameter. Most of the individuals had red fruits, while a few had white fruits. A detailed account of the fruiting phenology of fleshy-fruited plants in Point Calimere is described elsewhere (Balasubramanian and Bole 1993b).

The Fruits: Table 2 summarizes the various classes of bird-fruits in Point Calimere. Red (25) and Black (17) are the principal colours, which constituted 65.6% of the total bird-fruit species in Point Calimere. Yellow, blue, white, green and orange are other colours among bird-fruits. Fruit size ranged from 3.9 mm to 69 mm. The majority of bird-dispersed fruits had a mean diameter of less than 10 mm (42 out of 64). A total of 42 fruit species had 1-2 seeds per fruit, out of which 35 species (55%) had only a single seed. A total of 55 fruit species had seeds measuring less than 10 mm length. Remaining nine species measured more than 10 mm in length.

The Birds: A total of 20 bird species of 14 genera from 10 families were observed to eat fruits at Point Calimere (Table 3). None of the families were represented by more than two genera. Families represented by more than two species were Sturnidae (4), Corvidae (3) and Columbidae (3). Based on the census data, the status of frugivorous birds were put into three classes, namely i. Residents (R); (birds that are seen throughout the year), ii. Seasonal migrants (SM); birds that are seen most part of the year and are absent for a short period (2-4 months) and iii. Migrants (M); birds that are seen for a short period, especially during winter.

The major avian seed dispersers are two bulbuls (*Pycnonotus luteolus, P. cafer*), three mynas (*Sturnus malabaricus, S. pagodarum, Acridotheres tristis*), Rosy pastor (*Sturnus roseus*), Golden oriole (*Oriolus oriolus*), Koel (*Eudynamys scolopacea*),

TABLE 1
FRUITING PHENOLOGY OF BIRD-DISPERSED PLANTS IN POINT CALIMERE

	Month												Year
	J	F	M	A	M	J	J	A	S	O	N	D	
Total species in fruit	27	30	28	23	17	12	13	15	18	24	26	24	1987
N=64	31	29	32	16	15	13	17	14	26	20	26	29	1988

two crows (*Corvus macrorhynchos, C. splendens*), Indian tree pie (*Dendrocitta vagabunda*), Jungle babbler (*Turdoides striatus*) and Tickell's flowerpecker (*Dicaeum erythrorhynchos*). Two doves *Streptopelia chinensis, S. decaocto*) and Rose-ringed parakeet (*Psittacula krameri*) were seed predators. *P. krameri* visited the fruiting trees mainly for eating the seeds. The fruits of Sapotaceae (e.g., *Manilkara hexandra, Mimusops elengi* and *Madhuca longifolia*) were largely attacked by this bird. *S. chinensis* and *S. decaocto* visit the fruiting trees mainly to eat the fruits, but while doing so they damage the seeds, and are hence included in this class. Though pigeons and doves are generally considered as seed predators (Ridley 1936), *Treron bicincta* was found to disperse seeds of a few plant species. The analysis of faeces collected from roosting sites showed a large number of uninjured seeds of *Manilkara hexandra* and *Zizyphus oenoplia.* Two sunbirds (*Nectarinia zeylonica* and *N. asiatica*) visited the plants such as *Lepisanthes tetraphylla* and *Salvadora persica,* bearing juicy fruits, to sip the

TABLE 2
FREQUENCY DISTRIBUTION OF 64 FRUIT SPECIES BASED ON DIFFERENT PARAMETERS

Fruit colour n=64	Black	Blue	Green	Orange	Red	White	Yellow
	17	5	2	2	25	4	9

Fruit diameter n=64	<10	10-20	>20
	42	14	8
Number of seeds n=64	1-2	3-15	>15
	42	12	10
Seed length (mm) n=64	<5	5-10	>10
	24	31	9

TABLE 3
AVIAN FRUGIVORES AND THEIR GAPE SIZE OBSERVED AT POINT CALIMERE

Family/Species	Common name	Code	Status	Gape Width (mm)	
				Mean	Range
COLUMBIDAE					
Treron bicincta	Orangebreasted Green Pigeon	(OP)	SM	10.3	9.7 - 11.0
Streptopelia decaocto	Indian Ring Dove	(RD)	R	7.9	7.8 - 8.0
Streptopelia chinensis	Spotted Dove	(SD)	R	8.6	7.1 - 10.0
PSITTACIDAE					
Psittacula krameri	Roseringed Parakeet	(RR)	R	14.6	13.7 - 15.3
CUCULIDAE					
Eudynamys scolopacea	Koel	(KL)	SM	17.5	15.5 - 19.7
ORIOLIDAE					
Oriolus oriolus	Golden Oriole	(GO)	SM	11.2	10.8 - 11.6
STURNIDAE					
Sturnus malabaricus	Greyheaded Myna	(GM)	SM	9.0	8.8 - 9.6
Sturnus pagodarum	Brahminy Myna	(BM)	SM	9.2	8.0 - 11.2
Sturnus roseus	Rosy Pastor	(RP)	M	9.6	9.2 - 10.2
Acridotheres tristis	Common Myna	(CM)	R	10.5	9.8 - 11.2
CORVIDAE					
Dendrocitta vagabunda	Indian Tree Pie	(TP)	R	14.5	13.7 - 14.9
Corvus splendens	House Crow	(HC)	R	19.0	16.8 - 19.9
Corvus macrorhynchos	Jungle Crow	(JC)	R	22.8	22.0 - 23.6
PYCNONOTIDAE					
Pycnonotus cafer	Redvented Bulbul	(RB)	R	9.5	8.9 - 10.0
Pycnonotus luteolus	Whitebrowed Bulbul	(WB)	R	11.4	11.2 - 12.0
MUSCICAPIDAE					
Turdoides striatus	Jungle Babbler	(JB)	R	11.6	10.5 - 12.6
Acrocephalus dumetorum	Blyth's Reed Warbler	(BW)	M	5.4	5.2 - 5.9
DICAEIDAE					
Dicaeum erythrorhynchos	Tickell's Flowerpecker	(TF)	R	5.0	4.6 - 5.5
NECTARINIDAE					
Nectarinia zeylonica	Purplerumped Sunbird	(PR)	R	4.7	4.5 - 4.8
Nectarinia asiatica	Purple Sunbird	(PS)	R	4.9	4.4 - 5.5

sweet juice. While doing so, the seeds are neither damaged nor ingested and hence the birds are called as fruit thieves. Blyth's reed warbler (*Acrocephalus dumetorum*) was neither a legitimate seed disperser nor a seed predator. It visited only one plant (*Salvadora persica*) to eat the seedless fruits which were ingested whole.

The various plant species whose fruits were eaten by birds at Point Calimere are given in Table 4. *Pycnonotus luteolus* visited the maximum number of plants (63) followed by *Pycnonotus cafer* (51), *Eudynamys scolopacea* (32) and *Acridotheres tristis* (27). Three plant species were visited by more than 10 bird species. The tree species with the largest number of bird species visit was *Salvadora persica* (15) followed by *Manilkara hexandra* (12) and *Ficus infectoria* (11). The percentages of visits made by various fruit eating birds to 22 fleshy-fruited plants are given in Table 5.

Seasonal Fluctuations of Frugivorous Birds: Fluctuation in the number of species as well as individuals of frugivorous birds was noticed during different seasons in both the years of study. The highest number of frugivorous bird species occurred during November (monsoon) in 1987 (17) and in December (monsoon), February and March (post-monsoon) in 1988 (19) (Fig. 1). There was a significant difference in the number of species that

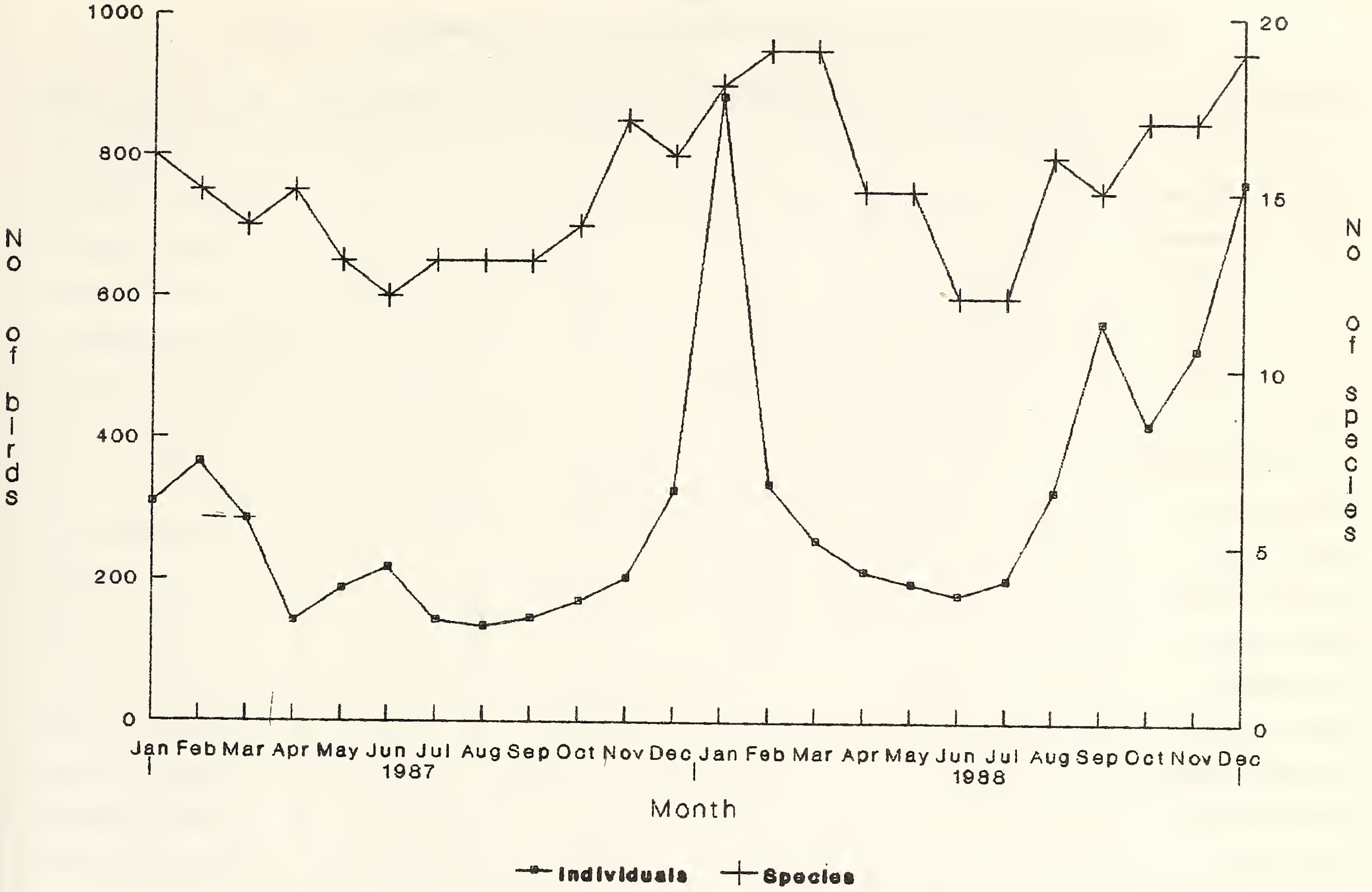

Fig. 1. Number of frugivorous bird species and individuals observed along census route.

occurred in 1987 and 1988 (Wilcoxon's signed rank test, $p < 0.05$). The number of frugivorous bird species was low during summer and pre-monsoon and the lowest number (12) occurred during June (summer) in 1987, and during June and July (summer and pre-monsoon) in 1988.

The lowest number of individuals of frugivorous birds (141) occurred during April (summer) in 1987, (180) in June (summer), in 1988 (Fig. 1). The number of individuals of frugivorous birds was generally low during summer and pre-monsoon in both the years. The highest number (364) of individuals of frugivorous birds occurred during February (post-monsoon) in 1987. In 1988, the highest number (764) was noticed in December (monsoon). In 1988 a small fruiting peak was noticed in September which was due to the influx of *Acridotheres tristis* from the neighbouring villages to *Syzygium cumini* trees, which were in mass fruiting. During summer and pre-monsoon (between June and August) resident birds were found in low numbers. During these seasons, species such as *Pycnonotus luteolus, P.cafer, Acridotheres tristis, Streptopelia chinensis* and *S. decaocto* made local migrations to the neighbouring villages in search of food.

Gape Width Size: The mean gape width of fruit-eating birds ranged from 4.7 mm to 22.8 mm. However, if sunbirds and Blyth's reed warbler which are non seed dispersers and Tickell's flowerpecker which is specialized in dispersing the seeds of mistletoes are excluded, the mean gape width diameter ranges from 7.9 to 22.8 mm.

DISCUSSION

In Point Calimere, a significant correlation was noticed between the number of plant species in ripe

TABLE 4
FRUIT SPECIES EATEN BY VARIOUS BIRDS AT POINT CALIMERE SANCTUARY*

Plant species	OP	RD	SD	RR	GO	GM	BM	RP	CM	HC	JC	RB	WB	JB	TF	PR	PS	TOTAL
Pachygone ovata												d	d					2
Tinospora cordifolia							d	d	d	d	d	d	d					8
Capparis rotundifolia												d	d					2
Capparis zeylanica													d					1
Cretaeva adansonii													d					1
Flacourtia indica							d					d	d					4
Hugonia mystax											d	d	d					4
Glycosmis pentaphylla									d			d	d			t		4
Toddalia asiatica			p				d	d	d			d	d					7
Ochna obtusata													d					1
Azadirachta indica												d	d					2
Walsura trifolia	+											d	d					3
Olax scandens									d			d	d	d				5
Cansjera rheedii									d			d	d					4
Pleurostylia opposita										d		d	d					3
Salacia chinensis			+									d	d					3
Scutia myrtina												d	d					3
Zizyphus mauritiana													t					2
Zizyphus oenoplia						d	d		d			d	d					6
Cissus quadrangularis												d	d	d				4
Cissus vitiginea							d					d	d	d				4
Allophyllus serratus									d			d	d					3
Lepisanthes tetraphylla												t	+	+	t	t	t	6
Lannea coromandelica									d	d	d	d	d					6
Syzygium cumini	t								d			t	t					5
Memecylon umbellatum												d	d					2
Coccinia grandis		d	d	d		d	d		d			d	d	d				10
Trichosanthes cucumerina									d	d			d					4
Trichosanthes tricuspidata										d	d		d					5
Opuntia dillenii												d	d					2
Benkara malabarica												d	d					2
Canthium dicoccum									d			d	d	d				6
Canthium parviflorum									d		d	d	d					4
Ixora pavetta									d			d	d					4
Pavetta breviflora												d	d					3

* for bird species code see Table 3

TABLE 4 (*continued*)

Plant species	OP	RD	SD	RR	GO	GM	BM	RP	CM	HC	JC	RB	WB	JB	TF	PR	PS	TOTAL
Pavetta indica													d					1
Manilkara hexandra	d		p	p		d	d		d	d	d	t	t		t			12
Mimusops elengi				p									+					2
Diospyros ferrea												d	d					3
Jasminum angustifolium									d	d		d	d					4
Jasminum auriculatum									d				d					3
Azima tetracantha												d	d					2
Salvadora persica		+	+	p		+	+	+	d	d	d	d	d	d			+	15
Carissa spinarum												d	d					2
Carmona retusa												d	d	d				3
Cordia obliqua												d	d	d				3
Ehretia ovalifolia							d		d		d	d	d					6
Solanum trilobatum												d	d					3
Premna serratifolia									d			d	d					4
Cassytha filiformis													d		t			2
Dendrophthoe falcata															d			1
Viscum orientale													d		d			2
Viscum capitellatum													d		d			2
Breynia vitis-idaea												d	d					2
Drypetes sepiaria									d			d	d					4
Phyllanthus reticulatus												d	d					2
Securinega leucopyrus							d		d			d	d	d				6
Ficus benghalensis					d				d	d	d	d	d	d				9
Ficus microcarpa									d	d	d	d	d	d				8
Ficus religiosa					d				d	d	d	d	d					8
Ficus infectoria	d		d		d				d	d	d	d	d		d			11
Plecospermum spinosum	t								d			t	t					5
Asparagus racemosus												d	d					3
Phoenix pusilla												d	d					2
Total species eaten	5	2	6	4	3	4	10	3	27	12	12	51	63	12	7	2	2	

d = Seed disperser; p = Seed predator; t = Fruit thief; + = Unknown
For bird species names see Code in Table 3.

TABLE 5
PERCENTAGES OF VISITS MADE AND FRUITS CONSUMED BY THE FRUGIVOROUS BIRDS FROM VARIOUS BIRD-DISPERSED PLANTS

	Bird Species														
Plant Species	KL	CM	BM	GM	RP	TP	HC	JC	WB	RB	JB	OTH	Total	Visits *	Hours
Azadirachta indica									99.6	0.4			2	74	12
									(99)	(1)				(86)	
Cansjera rheedii	15	1							49	35			4	7	12
	(45)	(2)							(27)	(26)				(30)	
Canthium dicoccum	6	17				1			37	37	1		6	14	12
	(20)	(30)			(1)			(23)	(25)	(1)				(70)	
Cissus vitiginea			4						67	25	2		4	4	18
			(11)						(67)	(20)	(2)			(10)	
Cordia obliqua									89	10	1		3	19	12
									(87)	(12)	(1)			(49)	
Diospyros ferrea	9								85	6			3	3	12
	(23)								(76)	(1)				(12)	
Drypetes sepiaria	3	12							49	36			4	8	17
	(8)	(22)							(34)	(36)				(29)	
Ehretia ovalifolia	1	5	2					1	57	34			6	20	12
	(9)	(8)	(6)					(2)	(45)	(30)				(73)	
Ficus benghalensis	3	22				1	23	43	3.5	3.5	0.5	0.5	9	40	12
	(4)	(23)				(1)	(15)	(54)	(1)	(1)	(0.5)	(0.5)		(326)	
Ficus religiosa	2	31				1	6	12	27	18	3		8	31	17
	(9)	(37)				(3)	(6)	(8)	(18)	(17)	(2)			(140)	
Ficus infectoria	2	7				1	9	11	12	54	1	3	11	35	14
	(4)	(7)				(1)	(10)	(14)	(11)	(49)	(0.5)	(0.5)		(115)	
Glycosmis pentaphylla		5							83	9		3	3	6	15
		(30)							(59)	(11)				(13)	
Ixora pavetta	6	1							62	31			4	10	18
	(30)	(3)							(49)	(18)				(49)	
Manilkara hexandra	6	16	7	4			12	2.5	28	2		22.5	12	10	33
	(19)	(31)	(6)	(9)			(28)	(5)	(0)	(0)		(2)		(40)	
Olax scandens	8.5	18							58.5	8	7		5	9	15
	(23)	(33)							(32)	(4)	(8)			(49)	
Phyllanthus reticulatus	17								26	57			3	6	12
	(34)								(20)	(46)				(25)	
Salvadora persica	1	24					11.5	12	23	19.5		9	9	16	21
	(1)	(38)					(16.5)	(21)	(11)	(12)				(127)	
Securinega leucopyrus	0.5	22	51.5						11	13	2		6	18.5	12
	(1)	(14)	(54)						(3.5)	(6)	(1.5)			(217)	
Solanum trilobatum		4							39	57			3	6	12
		(31)							(14.5)	(54.5)				(20)	
Tinospora cordifolia	10.5	13.5	1.5		2		5	1.5	41	25			8	7	20
	(20)	(21)	(1)		(3)		(12.5)	(2)	(26)	(14.5)				(34)	
Toddalia asiatica	4	2	11		3				41	38		1	7	10	15
	(8.5)	(4.5)	(12)		(7)				(36)	(30)		(2)		(41)	
Zizyphus oenoplia	0.5	21	28.5	23					14	13			6	26	15
	(0.5)	(27.5)	(32)	(31)					(5)	(4)				(289)	

TOT = Number of species recorded during observation period. For each species the given data represents the percentage of visits made by species,and (below, in parenthesis) the percentage of fruits removed by that species. * = Mean number of visits/hr and (below, in parenthesis) mean number of fruits consumed/hr.

For bird species names see Code in Table 3.

fruits and the number of fruit-eating bird species as well as individuals (Spearman rank correlation, $p < 0.05$). The migratory season (October-March) of birds corresponds with the availability of more fruit-bearing plant species. As the number of plant species that fruited during summer and pre-monsoon was very low, resident fruit-eating birds, namely *Pycnonotus luteolus, P.cafer, Streptopelia chinensis,* and *S. decaocto* showed local migration. These birds emigrated to neighbouring villages , six kilometre away from the sanctuary (Alagar Rajan, pers. comm.). Hence, bird-dispersed tree species such as *Walsura trifolia, Azadirachta indica, Lannea coromandelica, Crateva adansonii* and *Cordia obliqua,* whose fruiting was confined to the lean period and supports a large population of resident fruit-eating birds, become the keystone food resources in the community. All studies of tropical fruiting phenologies report seasonality, ranging from the extreme in forests with a distinct wet and dry season to minor in forests with heavy rainfall throughout the year (Howe and Smallwood 1982). In the forests with distinct wet and dry seasons, food may be more limiting in some seasons than in others. Consequently, trees which fruit during the lean season will play a greater role in maintaining entire communities of fruit-eating animals (Howe 1984).

A fine coordination between the frugivore abundance and fruit availability was noticed in the Bornean rain forest. Emigration of fruit-eating birds such as hornbills (*Rhyticeros*), pigeons (*Ducula, Ptilinopus*), the hill mynah (*Gracula*) and green broadbill (*Calyptomena*) during low fruit availability was noticed in the Bornean rain forest (Leighton and Leighton 1983). Foster (1982) described starvation of frugivores following climatically induced fruit crop failures on Barro Colorado Island, Panama, in 1970. Seasonal shift in fruit abundance was correlated with the fluctuating availability of fruit-eating birds at La Selva (Levey 1988).

Salvadora persica produced seedless fruits during February to April during which about 15 bird species visited it to eat the fruits. Flocks of *Sturnus roseus* visited the fruiting plants. Very large numbers of *S. roseus* were noticed only during these months. The birds fed voraciously on the fruits. The migrant bird, *Acrocephalus dumetorum,* which is chiefly insectivorous, was also found to feed on the fruits of *Salvadora.* The population of *A. dumetorum* was high during these months.

In South Africa, warblers *Sylvia*, bulbuls *Pycnonotus* spp., weavers *Ploceus* spp., sparrows *Passer* spp., Bluenaped Mousebirds *Colius macrourus*, and Yellow-Fronted Tinkers *Pogoniulus chrysoconus* visiting *Salvadora persica* trees to feed on the sterile fruits were reported by Fry *et al.* (1970). They found that *S. persica* fruits are lipid free and sugar-rich and readily assimilable by birds. From the retrapped birds, during that season, they recorded the weight variation in those bird species and concluded that migratory birds lay down fat before the return migration and also that the insectivorous birds could change their diet from the protein rich insects to sugar-rich pulpy fruits.

From the observations made at Point Calimere on the visitation of *Acrocephalus dumetorum,* an insectivorous bird, to *Salvadora persica* for feeding on the sterile fruits and the seasonal abundance and large scale visitation of *Sturnus roseus* to *Salvadora persica*, it can be presumed that these two bird species eat *Salvadora persica* fruits mainly to lay down their fat reserves, before starting on the return migration. The seedless fruiting by *Salvadora persica* during this season readily helps these two bird species in this purpose.

Fruit Colour Spectra of Bird-dispersed Plants: Published data for fruit colour spectra of the bird-dispersed plants of certain other geographic regions can be compared with those of Point Calimere. Wheelwright and Janson (1985) found no differences in fruit colour spectra in Costa Rica, Peru and Florida, where black-fruited species were the most common (34-41%). In European flora, red fruited species are more common (Turcek 1963). Bird-fruits from other regions were red (see Gautier-Hion *et al.* 1985 for Gabon; Knight and Siegfried 1983 for South Africa, and Beehler 1983 for New Guinea). In Point Calimere red followed by black

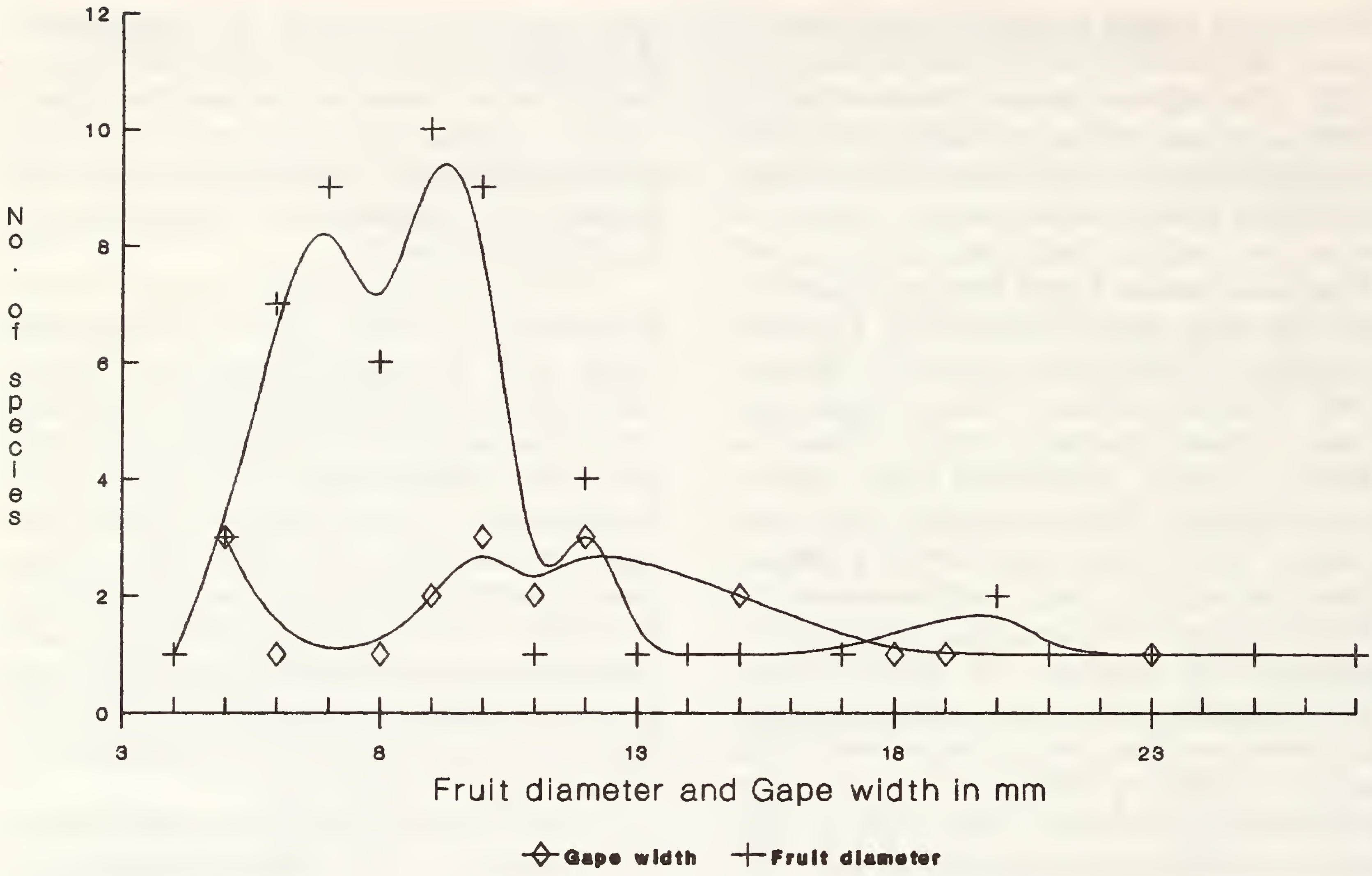

Fig. 2. Frequency distributions of mean diameter of fruits and gape width of frugivorous birds

are the principal colours among bird-fruits, which corresponds with the other regions.

At Point Calimere there was an association between small size and black and red colours of fruits. A total of 16 fruits out of 17 black and 14 out of 25 red had fruits measuring less than 10 mm diameter. Thus, the black and red fruits being smaller-sized, are easily consumed by birds, and contribute a significant share in the food plants of frugivorous birds of Point Calimere.

Fruit Size and Number of Seeds: The majority of bird-fruits in Point Calimere have a mean diameter of 4-20 mm. In the lower montane rain forests of Costa Rica, the majority of plant species (69.1%) had fruits with a diameter of 5-12 mm. About 48.9% of the species had single-seeded fruits. Only 23.8% of fruits had more than 10 seeds (Wheelwright 1985b). In Eastern North America, the size of the bird-fruits ranges from < 5 to 10 mm. In east-central Illinois, the mean diameter of many bird-fruit species is about 7-8 mm. The average number of seeds per fruit varies from 1-36 in 21 species, out of which 14 species average only one or two seeds per unit (Johnson *et al.* 1985). In Papua New Guinea, the fruit diameter of figs ranges from 6-28 mm, berries and drupes 6-20 mm (Beehler 1983). The Point Calimere figures correspond with those of the bird-dispersed fruit characters reported for the study areas such as New Guinea (Beehler 1983), Illinois (Johnson *et al.* 1985) and Costa Rica (Wheelwright 1985b).

Fruit Size and Gape Width: The fruit diameters of bird-dispersed plants at Point Calimere ranged from 3.9-69.0 mm. The gape width of the frugivorous bird species ranged from 4.7-22.8 mm. The distribution of gape width sizes of fruit-eating birds at Point Calimere did not match fruit diameters (Fig. 2).

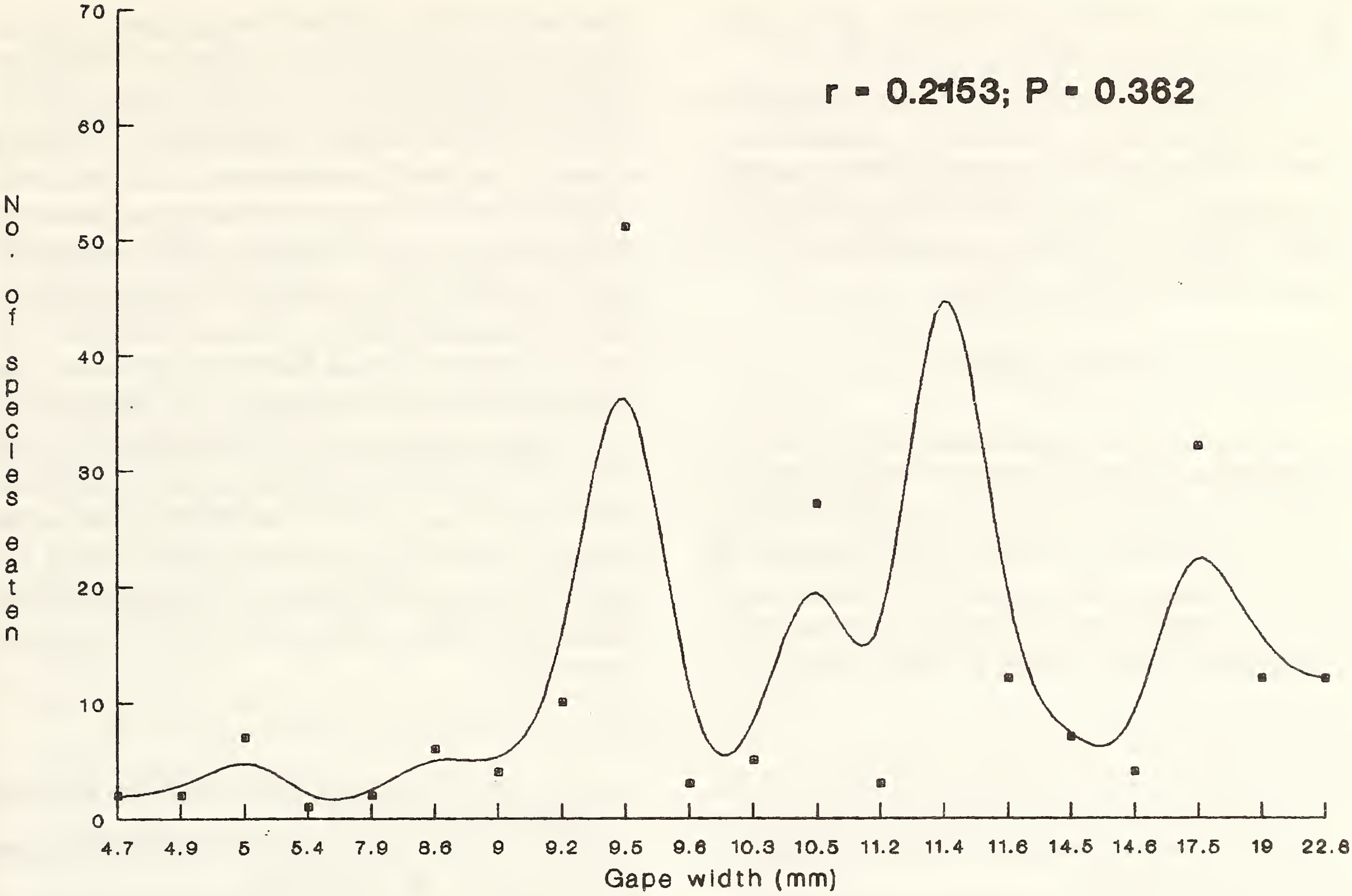

Fig. 3. Gape widths of birds *vs* number of fruit species eaten

Irrespective of their gape width, birds ate fruits of various sizes. In the case of larger fruits, birds with large gape width swallowed the whole fruit, whereas the birds with smaller gape width ate the pulp only. Seeds which could not be swallowed were dropped. Birds with relatively small or large gape width visited fewer plant species while birds of medium-sized gape width visited the largest number of plant species (Fig. 3). However, there was no significant correlation between gape width size and the number of fruit species eaten (r = 0.2153; p = 0.362).

According to Terborgh and Diamond (1970), small-fruited plant species attract more bird species than large-fruited ones. In Mexico, intermediate-sized fruits draw the largest number of bird species (Kantak 1979). Wheelwright (1985b) concludes that 1. small-fruited plant species draw significantly more species of birds than large-fruited ones, 2. large-gaped birds feed commonly on small fruits; and 3. a correlation exists between the gape width size and the number of lauraceous fruits eaten by those birds. The results of this study agree with the first two of these points of Wheelwright (1985b) and disagree with the third point, the reason being that Wheelwright's observations were on one guild (lauraceous) of plants and frugivorous birds and the present study is on plants in a whole community and fruit-eating birds.

In addition to birds, the Short-nosed Fruit bat (*Cynopterus sphinx*) Jackal (*Canis aureus*), small Indian civet (*Viverricula indica*) and the Bonnet Monkey (*Macaca radiata*) also dispersed the seeds of fleshy-fruited plants. Out of 64 bird-dispersed plants, 30 species were dispersed by *Cynopterus sphinx*, 20 by *V. indica* and 18 by *C. aureus*. Fruit species that were not eaten by birds (e.g., *Atalantia monophylla, Gmelina asiatica, Achras sapota* and

Madhuca longifolia) are dispersed by *C. sphinx* (Balasubramanian and Bole 1993a).

Even though nearly 50% of the fleshy-fruited species in Point Calimere are eaten by mammals, only 10% of the species are solely dispersed by mammals. For the remaining species, birds were the main dispersal agents. Therefore, most seed dissemination in this forest must be attributed to birds.

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STRATEGIES FOR LONG-TERM CONSERVATION OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* IN INDIA

ASAD R. RAHMANI[1]

(*With two plates and a text-figure*)

The Great Indian Bustard *Ardeotis nigriceps* is one of the rarest birds of the Indian subcontinent, with an estimated population of 1500 to 2000 in the 1980s. It is now found only in six states of India. All these states have taken some conservation measures by declaring protected areas such as Karera Bustard Sanctuary in Madhya Pradesh, Rollapadu Wildlife Sanctuary in Andhra Pradesh and Jawahar Lal Nehru Bustard Sanctuary (Nannaj) in Maharashtra. However, due to ineffective habitat protection in most of these areas and extensive poaching in the Thar desert, the bustard population has declined by almost half, and now perhaps less than 1000 are left in the whole country. Strategies for the long-term conservation of bustard and its grassland habitats are given in this paper. It is also strongly urged to start a centrally-sponsored 'Project Bustard' on the pattern of Project Tiger and Project Elephant to save all the species of bustards and other denizens of the Indian grasslands.

INTRODUCTION

The Great Indian Bustard *Ardeotis nigriceps* is one of the rarest birds of India (Ali 1970, Goriup and Vardhan 1980, Rahmani 1987, 1989a) and one of the rarest bustards of the world (Johnsgard 1991, Collar *et al.* 1994). In the mid 1980s, bustard population was estimated to be between 1500 to 2000, with half of the surviving birds in Rajasthan (Rahmani and Manakadan 1990). This big variation in the estimate was mainly because Rajasthan could not be surveyed properly and the bustard survived in a vast area of nearly 2,00,000 sq km of the Thar desert (and two areas in eastern Rajasthan) (Rahmani 1986, 1989a). Recent studies and surveys reveal that bustard numbers have almost halved in ten years in the Thar desert (Rahmani 1994a).

The Great Indian Bustard is still surviving in six states but its status is precarious in Madhya Pradesh, Gujarat and Karnataka. The Rajasthan state, where more than half of India's bustards survive, has not taken effective measures. It is seen in many areas in the Thar Desert but conservation measures are inadequate to face the increasing pressure of livestock and human populations (Rahmani 1994a). Even the Desert National Park in Jaisalmer and Barmer districts of Rajasthan is facing threats of habitat alteration by construction of a tributary of the Indira Gandhi Canal, earlier known as the Rajasthan Canal (Rahmani 1989b, 1994). The tributary of the Canal will bifurcate the Park. Presently the human population is very low (less than 10/sq. km) but once the tributary is completed, outsiders will settle in the area and a large part of the Park will be colonized by man.

Over-grazing, human disturbance, increase in Blackbuck *Antilope cervicapra* numbers resulting in resentment by villagers, poaching and mismanagement of habitat are some of the common problems faced by bustard sanctuaries. But, each sanctuary has its own specific problems also, which cannot be discussed here due to lack of space. At the end of this paper, management of a typical bustard sanctuary is described in detail, which can solve most of the general problems faced by bustard sanctuaries.

SURVEYS

This paper is based on almost 15 years of study on the Great Indian Bustard. Between 1981 and 1988, studies were conducted under the Endangered Species Project under the guidance of Dr Sálim Ali and Mr. J. C. Daniel, and from 1991 to 1996, monitoring of bustard populations and surveys of some states were done under the Grassland Ecology

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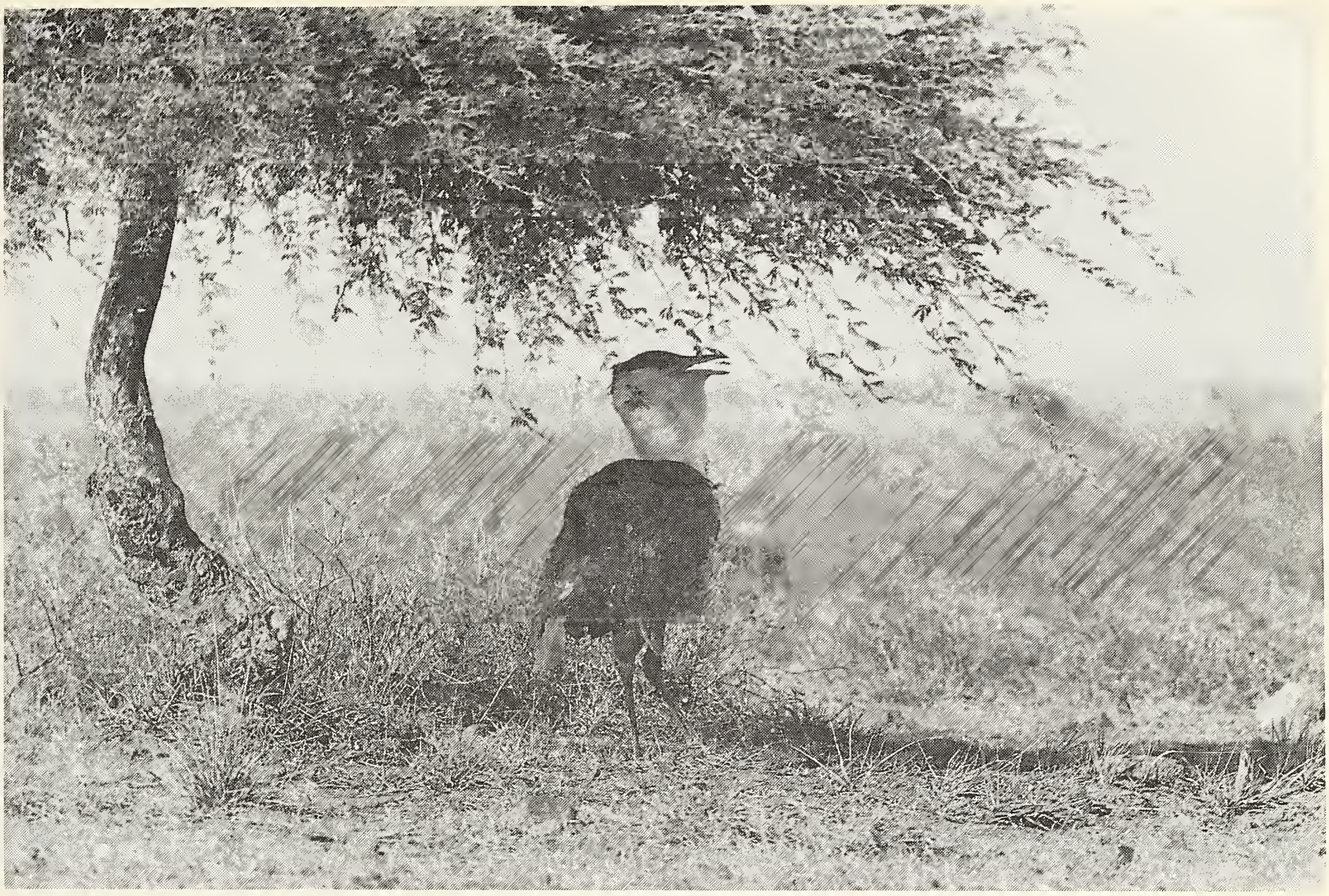
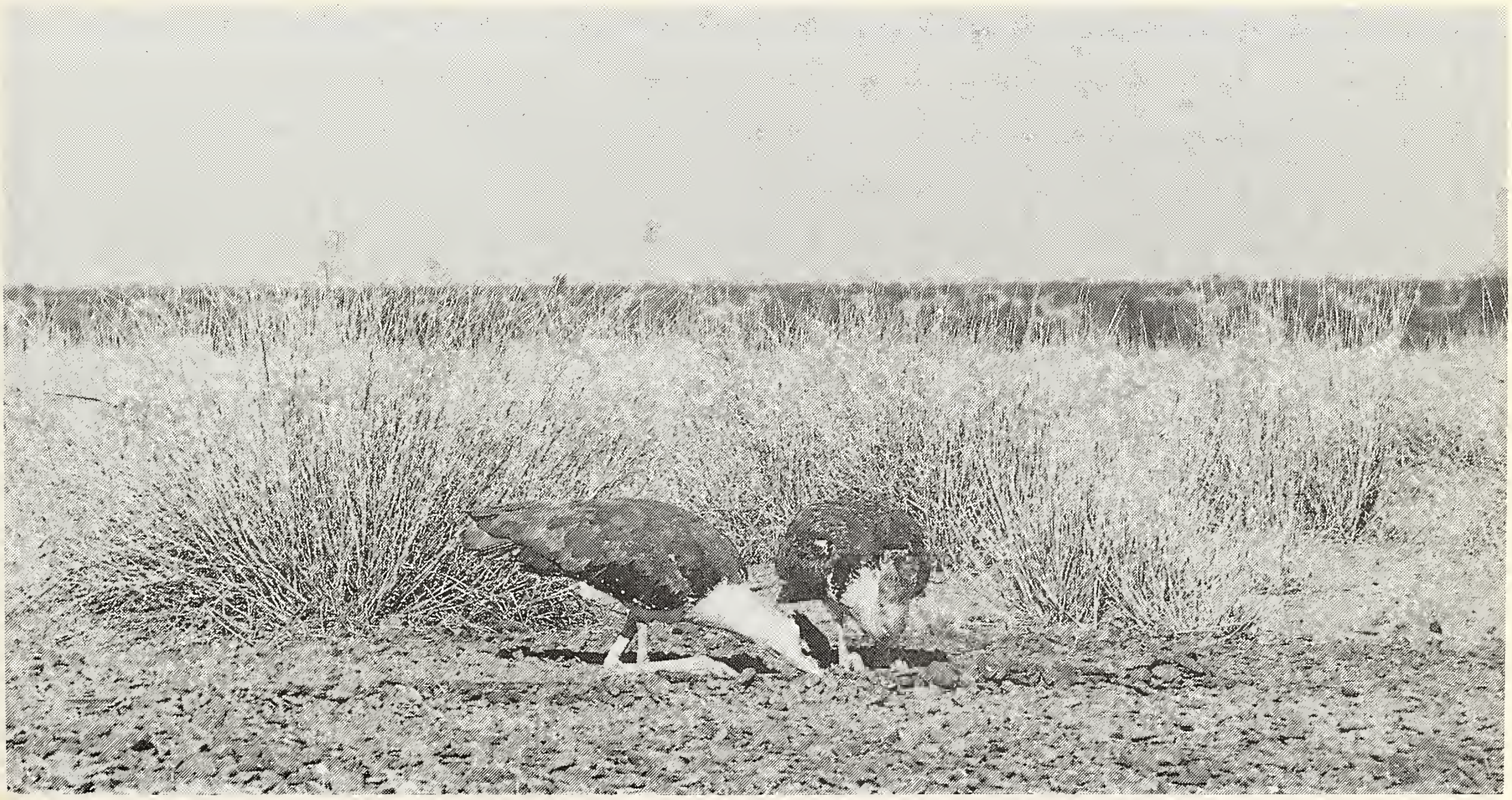
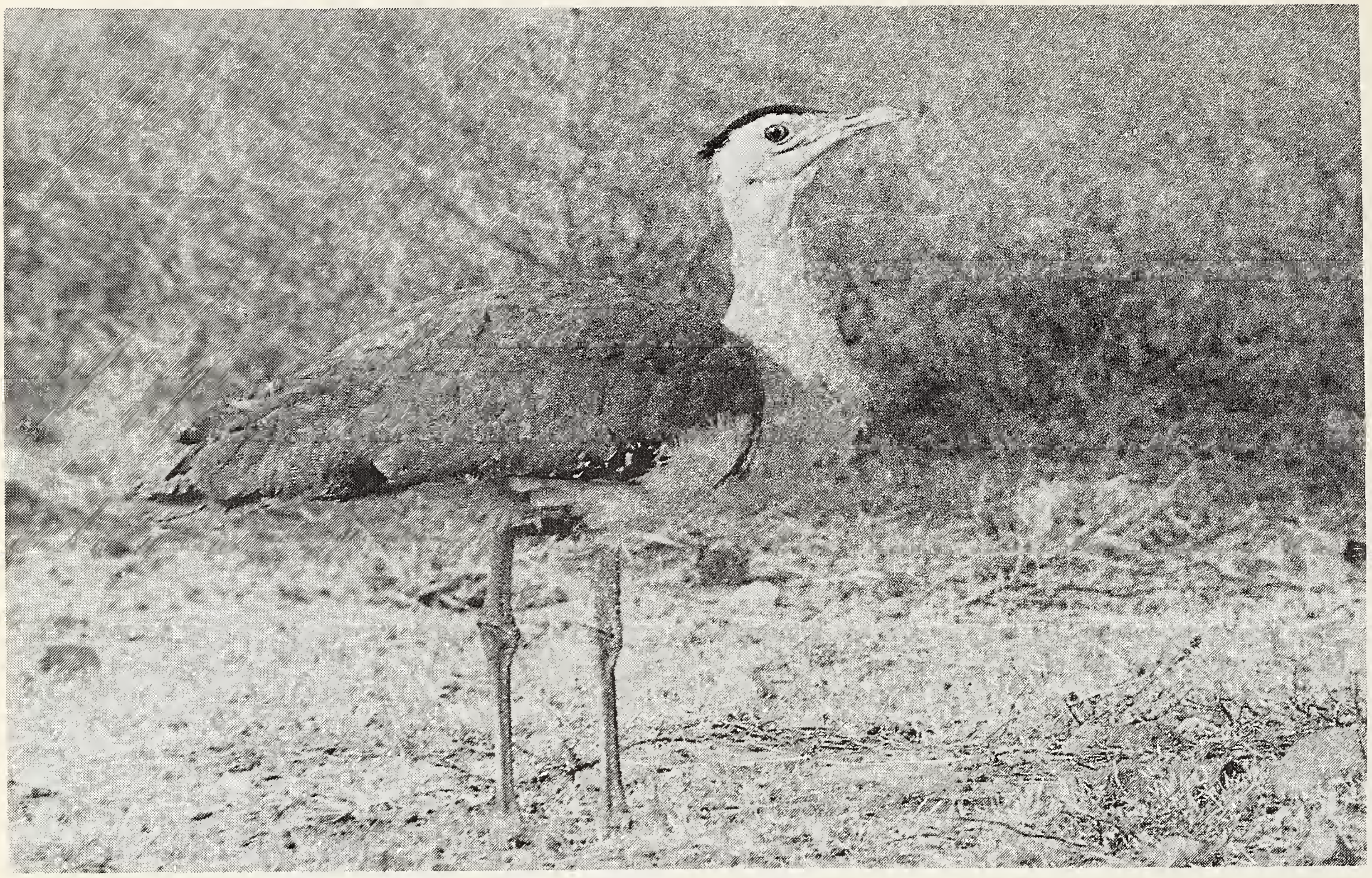


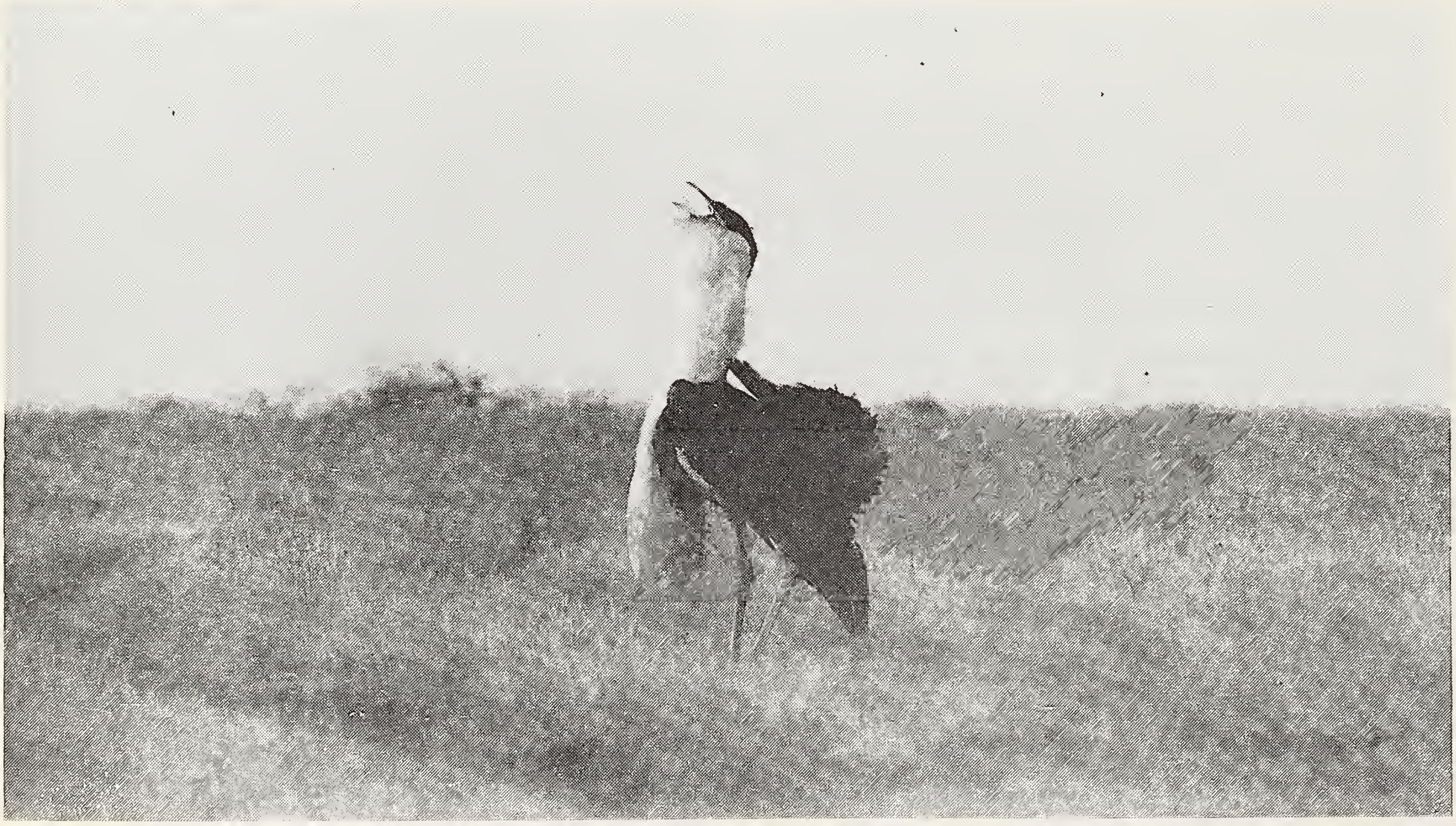
1A. During the hotter part of the day, especially in summer, the bustard rests in the shade of a small tree or bush.



1B. Although it is a facultative drinker, an artificial waterhole in a core area can attract many bustards.



2A. The Great Indian Bustard prefers short grassy, plains, with scattered bushes and trees of a height below its level. This is a female foraging at Karera Bustard Sanctuary.



2B. For courtship display, an adult male bustard selects an open area with a panoramic view. Strong site fidelity is noticed and one display site is being occupied every year since 1980.

TABLE 1
GREAT INDIAN BUSTARD SIGHTINGS IN THE 1980s AND IN 1993-94

State	Area	Earlier numbers	In 1992/93
Madhya Pradesh	Karera	20-25 (1983-86)	4-5 (1993)
	Ghatigaon	12-15 (1983-85)	3-5 (1993)
	Pohri	10-15 (1983-84)	Not surveyed but a few still survive
	Panna	5-10 (1988)	Not surveyed
Gujarat	Bhatia	5 (1984)	None seen in 1993 but still survives
	Lala	1 (1984)	5 (1991) 9 (1994)
Maharashtra	Nannaj	10-13 (1981)	40-45 (1994)
	Karmala	8 (1981-82)	None
	Kamuni	5-8 (1981-84)	3 (1992)
	Chapedgaon	1 (1983)	3 (1992)
	Virgaon	4 (1980s)	No recent survey
Andhra Pradesh	Rollapadu	50 (1987-88)	50 (1994-95)
Karnataka	Rannibennur	5-10 (1984-85)	5-6 (1994)
Rajasthan	Sorsan	8-10 (1984-86)	8-10 (1991-92)
	Sonkhaliya	30 (1986)	None (1993*) 17 (1994)
	Diyatra	13 (1986)	4 (Feb. 1993) None (July 1993) 2 (Jan. 1994)
	Bap	11 (1983)	6 (Feb. 1993) None (July '93) 5 (Feb. 1994)
	Sam-Sudasari	25-30 (1986)	5 (Feb. 1993) 15 (July 1993) 35 (May 1994)
	Khuri	14 (1986)	None (1993)
	Miyajlar	5 (1986**)	None
	Khinya-Madha	13 (1983)	None (1994)
	Sankara	1 male (1986)	None (1994)

* Up to '90 reported by the Forest Department.
** Reported by the Forest Department.

Project. In 1993 and 1994, four major surveys were done in the Thar desert through projects funded by the World Wide Fund for Nature (WWF-India) and Oriental Bird Club (U.K.). Brief surveys of Madhya Pradesh and Gujarat were done from time to time. Only Karnataka state could not be surveyed in recent years. However, data about bustard in Karnataka were collected from the Forest Department and other sources.

As the bustard is patchily distributed, attempts were made to do total counts in those months when the bustard concentrate for breeding. Wherever I could not see the bustard, an intelligent guess was made based on interviews of local people and many other independent sources. Data supplied by one source was cross-checked with other source(s). Local naturalists and ornithologists were contacted frequently, and officials of the Forest Department were interviewed/contacted.

Here I first discuss the comparative status of bustard in the 1980s and 1990s, then make specific recommendations for some bustard sanctuaries, and then discuss long-term management of bustard sanctuaries, and finally the need for a centrally-funded Project Bustard, on the lines of Project Tiger and Project Elephant.

BUSTARD SANCTUARIES IN INDIA

Presently there are nine protected areas specifically developed for the conservation of the Great Indian Bustard (Table 1).

Statewise Status of the Bustard

Following is a brief state-wise status report of the Great Indian Bustard in 1994:

1. *Madhya Pradesh*: In Madhya Pradesh there were four known bustard areas: Karera and Pohri (Shivpuri district), Ghatigaon (Gwalior), and Gunnaur (Panna). Ironically, the greatest decrease in bustard numbers is seen in Karera and Ghatigaon bustard sanctuaries which were specially established in 1980 for the protection of this species. In the mid 1980s, the total bustard population in these four areas was estimated to be around 50, with Karera and Ghatigaon having 30-35 birds (Rahmani & Manakadan 1990) but since the late 1980s there has been a progressive decrease of bustards in these sanctuaries, and now not more than 5-10 birds are left (Rahmani 1994a). A few bustards still survive in Pohri and Panna. The total population in Madhya Pradesh is estimated to be between 10-15 birds.

2. *Gujarat*: By the 1980s, the bustard had become extremely rare in Gujarat and survived only in two districts : Bhatia in Jamnagar, and Kutch (Rahmani 1985). There was a stray record from Surendranagar district (Rahmani and Manakadan 1990). The total population in the whole of Gujarat was estimated to be between 20 and 30 birds. During the last ten years, there appears to be almost a 50% drop in numbers. In 1990, a small bustard sanctuary of 200 ha was established near Lala village where breeding was also noted. In July 1994, nine bustards were seen in this area (Ravi Sankaran, pers. comm.).

In the Bhatia area of Jamnagar district, the Gujarat government is planning a bustard sanctuary where 4-5 birds are still present. In 1983 we had seen five birds, including an immature male which shows successful breeding. During our visit in August 1993 we could not see any bird but found evidence that less than five may still survive. It is doubtful if the population can recover from such a low number. The total population of bustard in Gujarat could be as low as 15.

3. ***Maharashtra***: Nannaj area in Solapur district has shown the most satisfactory increase in bustard numbers, mainly because the Forest Department took good measures to protect its grassland habitat. In 1981, the maximum number seen by us was only eight. In August 1993, we counted up to 37 bustards, and our estimate is that there are about 45 birds in Nannaj and surrounding areas (Rahmani and Kumar, in press). This increase is due to successful breeding and immigration of birds from surrounding areas. Beside Nannaj, bustard is still seen in Karmala, Kamuni, Chapedgaon, Mirajgaon and many other DPAP protected plots.

In Maharashtra, the bustard is seen in Solapur, Ahmednagar, Pune, Aurangabad, Nagpur and sometimes in Osmanabad districts, and the minimum population could be 60 birds.

4. ***Andhra Pradesh***: Rollapadu Bustard Sanctuary in Kurnool district has also shown positive results, thanks to effective protection of the bustard and its grassland habitat (Manakadan and Rahmani 1989), especially during the initial stages of establishment of the sanctuary. Successful breeding was seen every year. However, there appears to be some laxity in protection when the birds wander outside the sanctuary, hence the increase in the numbers is not as much as projected (Manakadan and Rahmani 1993). We have unconfirmed reports of bustard shooting by rich vehicle-borne poachers from Hyderabad. This could be one of the reasons why the population has not increased further. During

1987-88, we estimated around 50 bustards in the Rollapadu grasslands. Our present estimate (in 1995) is also the same. The total population in the whole state could be between 60 to 80.

*5. **Karnataka***: In Karnataka, bustards are chiefly seen around Rannibennur Blackbuck Sanctuary and Guttal plantation in Dharwad district (Rahmani and Manakadan 1990). However, as the sanctuary itself is not very suitable for bustards due to excessive growth of eucalyptus, the birds are seen outside the sanctuary in grazing land which suffer from over-exploitation (Neginhal 1980). Probably, 10 bustards are left in the whole state.

*6. **Rajasthan***: During our studies on bustards in the 1980s, we estimated that more than half of the bustards in India are present in Rajasthan, mainly in the Thar desert (Rahmani and Manakadan 1990). The populations appeared to be secure, and a sort of complacency had developed. In my recent four surveys in 1993 and 1994, I found that all over the Thar desert, the bustard population has drastically declined. My estimate in 1994 is that probably 500 bustards are left in the whole of Rajasthan (Rahmani 1994b).

PRESENT CONSERVATION MEASURES

The Great Indian Bustard is protected under Schedule I of the Wildlife (Protection) Act, 1972. Presently there are nine bustard sanctuaries and a few more protected areas where bustards are seen. Some of these sanctuaries were established in the early 1980s.

Strategies for bustard conservation in Rajasthan: The Rajasthan Government has declared the Great Indian Bustard as the State Bird. The State Forest Department has also given attention to the protection of this endangered bird by declaring some 'Closed Areas for Shooting', such as Sonkhaliya, Sorsan, and Diyatra. But except for posting of one or two disinterested guards, without any vehicle to patrol their vast and inhospitable areas, further steps have not been taken to protect the Closed Areas. The bustard population has declined, which proves that the protection measures are inadequate and much more has to be done if we want to save this species.

As Rajasthan State has more than half of the bustards of India, it has to play a major role in its conservation. Urgent steps should be taken to protect its habitat and to control poaching.

The following are some of the important measures which can help in reversing the decline of the Great Indian Bustard in Rajasthan:

A. Wildlife Wing

1. The Wildlife Wing of the Forest Department should become more active by having offices/branches in Nagaur, Phalodi, Pokhran, Ramgarh and Diyatra.
2. Dual charge of the ACF/DFO should be stopped, and the ACF/DFO should solely look after wildlife protection. (Presently both the ACFs at Bikaner and Jodhpur are also in charge of local zoos, so they do not get time to look after wildlife.)
3. Petrol-driven vehicles should be provided to officers.
4. The Anti-Poaching Unit should be strengthened, with proper vehicles and staff to patrol the vast areas.
5. The Forest Department should develop a network of informers, preferably from the Vishnoi community, who can help in apprehending poachers.
6. Honorary Wildlife Wardens should be appointed in each tehsil/village, who should preferably be selected from the Vishnoi community.

B. Wildlife staff

1. Better facilities to the staff of the Desert National Park. Presently, some do not have even a uniform, torch, transport and medical facilities, and have to live in remote areas in deplorable conditions.
2. Increase in the staff of the DNP to patrol the whole Park.

TABLE 2

EXISTING AND PROPOSED GREAT INDIAN BUSTARD SANCTUARIES

State	Name of the Sanctuary	Size*	Approximate no. Bustards
Andhra Pradesh	Rollapadu	6 sq.km	50-60
	Banganapalli Closed Area (Proposed)	-	10-15
Gujarat	Bhatia-Kalyanpur Area (Proposed)	-	4-5
	Lala Bustard Sanctuary	200 ha	9-10
Karnataka	Rannibennur Blackbuck Sanctuary	123 sq.km	5-8
Madhya Pradesh	Karera Bustard Sanctuary	202 sq.km	00
	Ghatigaon Bustard Sanctuary	512 sq.km	5-8
	Pohri Bustard Area (Proposed)	-	5-8
Maharashtra	Bustard Sanctuary (many DPAP plots)	7,818 sq.km	50-60
Rajasthan	Sorsan Closed Area (Kundanpur)	c. 40 sq.km	10-12
	Sonkhaliya Closed Area	17 sq.km	40-50
	Desert National Park	3,162 sq.km	100-150

* Here only the size of the protected areas is given.
The bustards roam in much larger areas.

3. Special desert allowance to the staff.

C. Protected Areas

1. Large grassland sanctuaries should be established in Ramgarh and Sultana grasslands, where only traditional grazing should be allowed and no surface water source should be developed.
2. Special emphasis should be given to develop grassland/pasture plots in the command area of the Indira Gandhi Nahar Project (IGNP) where cultivation is not possible due to underlying rocks or other edaphic factors.
3. The Satellite Conservation Units of the Desert National Park should be strengthened and expanded. Staff should be provided desert allowance, proper uniforms and housing.
4. Enclosures of Satellite Conservation Units of the DNP should be developed near Diyatra, Tokla, Bajju, Dantur, Bap, Khara, Undu, Khinya-Mandha, Sultana, Ramgarh and other places.

D. Publicity

1. Signboards informing that hunting is prohibited in the whole state should be put up at regular intervals at strategic points outside cities and towns.
2. Extensive publicity about wildlife protection should be started in schools, colleges, and among police and army officials.
3. Every year at the beginning of winter, publicity should be done in all sorts of media that hunting of Great Indian Bustard and other wildlife is totally prohibited.
4. Any poacher caught should be given quick and exemplary punishment and this should be publicized to deter other poachers.

E. Research

1. Research should be started to study the ecology and movement of the Great Indian Bustard by using telemetry.

TABLE 3
SPECIFIC DISTURBANCES TO BUSTARD AREAS IN THE THAR DESERT

Name	Type of disturbance	Protection measures	
		Taken	Proposed/Recommended
1. Desert NP	Construction of a canal*	None	Realignment of canal
i) Sam	Disturbance by tourists coming to see sand dunes	Posting of wildlife guards	Strict ban on tourists inside enclosure
ii) Sudasari	Over-growth of vegetation	Plan to cut vegetation	Restricted grazing by cows without cowherds
iii) Khuri	Lack of enclosure and overgrazing	None	Development of enclosure of 1000 hectares
iv) Miyajlar	Overgrazing	Not known	Facilities to guards and better protection
v) Bhandera	Grazing	Not known	Facilities to guards and better protection
vi) Sotto	Grazing	Not known	Facilities to guards and better protection
2. Diyatra	Shooting	One guard but lacking any facility	Facilities to guards and better protection Development of satellite enclosure of DNP
3. Bap	Shooting	None	Control on poaching. Posting of wildlife guards Development of satellite enclosure of DNP
4. Khinya	Shooting	None	Development of satellite enclosure of DNP Posting of wildlife guards
5. Sankara	Shooting ?	Posting of wildlife guards	Necessary facilities to guards
6. Ramdevra	Illegal *Salvadora* fruit collection Illegal grazing	Wildlife guards	Total ban on fruit collection and grazing
7. Dhanana	Shooting	None	Development of satellite enclosure of DNP Posting of wildlife guards Publicity and support of local people
8. Mohangarh	Inadequate protection	Not known	Development of satellite enclosure of DNP Publicity and support of local people
9. Dholiya	Shooting	None	Development of satellite enclosure of DNP Publicity and support of local people
10. Nokh	Inadequate protection	None	Publicity and support of local people
11. Undu	Shooting ?	None	Publicity and support of local people
12. Kanasar	Shooting ?	None	Publicity and support of local people

*General disturbance to the whole Park

2. Studies on the impact of the IGNP on the distribution of the Great Indian Bustard, Houbara *Chlamydotis undulata*, Imperial Sandgrouse *Pterocles orientalis* and other species should be conducted.
3. A general Environmental Impact Analysis of the IGNP on the common flora and fauna should be done.

Strategies for bustard conservation in Maharashtra: Theoretically the 8,496 sq. km Bustard Sanctuary of Maharashtra is the largest sanctuary in India! However, more than 90% of the land is under human occupation, with numerous villages, towns and crop fields. Only about 400 sq. km of the sanctuary area is under the Forest Department, not as a compact block but in various fragmented plots.

During the last fifteen years, except for the excellent protection to the bustard and other wildlife at Nannaj, not much work has been done to manage the huge Bustard Sanctuary. The Sanctuary falls under two districts, which creates administrative problems. Till now, even the crop protection guns which can be used for poaching have not been withdrawn from the sanctuary area. There is no control on grazing (nor is it possible), except in the Forest Department plots. These plots are scattered and the staff has not been given proper vehicles to visit them regularly. There are no long-term habitat protection plans for the sanctuary, except Nannaj which is now well known. Lesser known bustard areas like Karmala, Gangiawadi, Dahiwadi, Mirajgaon, Kamuni and Chapedgaon also need administrative attention because they are as important as Nannaj. With the increase and expansion of the bustard population, these areas will have to play an increasing role in bustard conservation.

The population of Blackbuck *Antilope cervicapra* has increased since the Bustard Sanctuary was declared in 1979. Crop damage by Blackbuck is a growing concern not only at Nannaj or Rehkuri, but in many parts of India. It should be studied in more detail before any long term action is taken. In bustard areas, no action should be taken which is detrimental to the welfare of the bustard. However, if nothing is done to minimize crop damage, the growing resentment among agriculturists may itself prove the biggest hindrance in the conservation movement.

RECOMMENDATIONS

1. The DPAP grassland plots of above 50 ha should be taken over by the Wildlife Wing of the Forest Department. More grassland plots of above 100 ha should be developed as core areas.
2. Livestock grazing and unnecessary movement of people should not be allowed inside the plots.
3. Special protection should be accorded to the plots during the breeding season i.e. June-November.
4. All plots should be encircled by trench-cum-mound walls.
5. The plots should be maintained as grasslands and tree planting should be avoided.
6. The plot should preferably form a catchment area of a percolation tank. This fact will give additional incentive to protect the vegetation of the plot. The percolation tank will provide water facilities to the fauna.
7. Each plot should have a watchman (preferably a local person).
8. A daily record of the sighting of bustards in each plot should be maintained. An annual census to know the trend of the bustard population, and an annual assessment of each plot should be made and necessary conservation and administrative changes should be done.
9. Tourist activity should be strictly controlled during the breeding season.
10. Proper staff, headed by a Conservator of Forest, should be appointed in the sanctuary.
11. Fresh assessment of the boundary of the sanctuary should be undertaken. Heavily populated areas should be excluded and some excellent bustard areas in Beed, Aurangabad

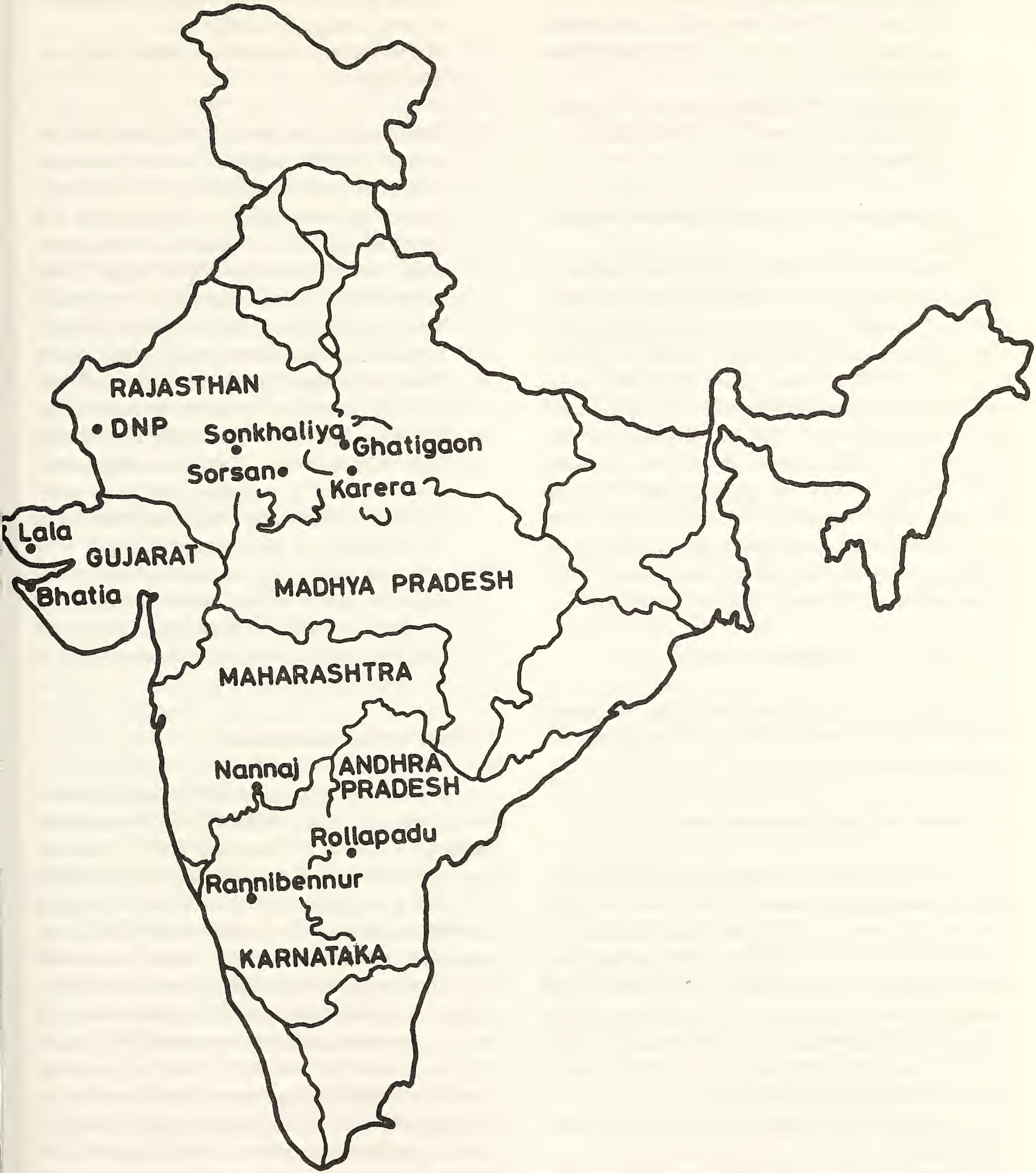

RAJASTHAN
DNP
Sonkhaliya
Ghatigaon
Sorsan
Karera
Lala
GUJARAT
Bhatia
MADHYA PRADESH
MAHARASHTRA
Nannaj
ANDHRA PRADESH
Rollapadu
Rannibennur
KARNATAKA

Fig. 1. Map showing bustard protected areas of India.

and Osmanabad should be included.

12. Research staff should be appointed and bustard movement studied by colour-banding and radio-telemetry.
13. Population of Blackbuck should be strictly controlled, either by translocation or sterilization or shooting.

Strategies for conservation in Andhra Pradesh:

Protected since 1982, with official status of wildlife sanctuary given in 1989, Rollapadu Wildlife Sanctuary (RWS) is the most important area for the Great Indian Bustard in Andhra Pradesh. It has a total area of 614 ha, most of which is made up of three grazing and disturbance free grassland plots of 420 ha (Enclosure I), 120 ha (Enclosure II) and 40 ha (Enclosure III). However, due to complaints from villagers of loss of grazing lands for their livestock, both Enclosure II and III are more or less (unofficially) open to grazing. Hence, most of the wildlife is concentrated in Enclosure I (see Manakadan and Rahmani 1989 for more details).

Recommendations

The following recommendations are offered for the better management of the Sanctuary, and for bustards in particular:

A. Control of Blackbuck numbers

Crop damage by Blackbuck is the major problem facing the Sanctuary. The Blackbuck which numbered 17 heads in 1985, and 38 in 1988, are now in the range of 250 -300 heads. Crop damage is a severe problem now, especially to crop fields in the vicinity of the Enclosure I. The support that the villagers of Rollapadu gave for the protection of the bustard and the Sanctuary is eroding due to depredations by the Blackbuck.

A combination of three measures could solve the problem.

1) Regular culling of the Blackbuck to maintain the population to below 100 - the population size at which there were very few complaints of crop damage by Blackbuck.
2) A compensation scheme for crop damage by Blackbuck.

3) Deepening and broadening of the trench-cum-mound (TCM) walls at the northern and southern boundaries of Enclosure I. Since, rain can silt up the trenches, an extra barrier of a hedge of *Gliricidia maculata* can be grown along the borders of the TCM walls. These physical barriers will reduce/stop crop damage at the northern and southern areas of Enclosure I, which are intensively cultivated. Since Blackbuck largely move out of the enclosure into the surrounding grazing lands after February, fencing of the eastern and western parts is not advised. Farmers in these areas may be offered *G. maculata* saplings to grow and fence off their crop fields from Blackbuck. *G. maculata* is recommended since it is observed to be very successful in such soil types (as seen from our studies at Nannaj). It is a legume and hence beneficial to crops. In addition, leaves of the same plant are used as fertilizer by farmers.

B. Strict control on poaching

During our studies at RWS totalling about seven years, we recorded only one instance of attempted poaching of bustards at RWS. However, some information was received that bustards were still being trapped by tribal shikaris around waterholes and crop fields outside the Sanctuary, especially when the bustards move out of the Sanctuary during the non-breeding season. Poaching outside the Sanctuary probably explains why the bustard population has not increased at RWS, inspite of good protection and high breeding success. Therefore, the Forest Department should not confine their activites to the Sanctuary area alone, but monitor outside areas known to be frequented by the bustards. A regular check should also be kept on the local *shikaris* who live in Nandikotkur.

C. Habitat management

The Great Indian Bustard is a bird of open grasslands, and avoids dense and tall vegetation. Dense growth of scrub will only result in habitat loss for the bustard, besides making the habitat suitable for predators like the Jungle cat *Felis chaus* and Wolf *Canis lupus* to hunt the bustard. Our studies show that there has been an increase in shrub and tree cover, especially along the streams of Enclosure I. This has made many areas unsuitable for the bustard. Thinning of the vegetation, especially along streams, is recommended. Shrub or tree species, which serve no purpose to the bustard in terms of shade or food (fruits) and which are recommended for thinning out or total removal are *Phoenix sylvestris*, *Dolichandrone falcata*, *Eucalyptus* sp. and *Leucanea leucocephala*, the latter two being exotic species.

D. Location of Administrative Headquarters

The administrative headquarters of the Sanctuary is situated at Srisailam, 165 km away. There have been plans to shift the headquarters nearer to Kurnool (50 km) . However, whatever the outcome, it is felt that there is a need to have a Range Forest Office at Nandikotkur (18 km) for the better management of the Sanctuary. Presence of a dedicated Range Forest Officer at Nandikotkur (with a vehicle) will result in better patrolling of the area, besides overall development of the Sanctuary.

E. Research

There should be regular monitoring of Bustard, Blackbuck, Lesser Florican and Wolf populations. Long-term research on bustard should be encouraged, using the latest telemetry methods to study the movement of bustards outside the Sanctuary.

Bustard conservation in Gujarat: The Lala Bustard Sanctuary (250 ha) in Naliya taluka of Kutch district is perhaps the most important bustard habitat left in Gujarat. All around Lala, vast grasslands still survive for atleast 20 km. Therefore, this area has long-term chances of survival, if proper steps are taken now. We recommend the following conservation steps:

(1) Further plantation of Mesquite *Prosopis chilensis* in the Sanctuary should be stopped. The existing Mesquite plants should be removed, especially during their non-fruiting season, and grassland should be restored.

(2) The grasslands adjacent to Lala Bustard Sanctuary such as Bara, Bitta, Tera, Prajau, Sindrodi, Pingleshwar, Vanku and Kothara are equally important for the conservation of the Great Indian Bustard, Lesser Florican, Houbara and endangered mammals like Chinkara *Gazella bennetti* and Wolf.

(3) Control on poaching: It is reported that due to the presence of an Air Force Station, poaching pressure in this area is high. The Air force officials poach wild animals using highly sophisticated weapons. Poaching is also done by landlords in the Tera and Prajau areas.

(4) The Gujarat Energy Development Agency encourages plantation of Mesquite and Eucalyptus in the grassland. Such exotic forests are named as Energy Plantations. An example of such a forest destroying the grassland can be seen near Sindrodi village, adjacent to Lala Bustard Sanctuary. Such plans should be discouraged in the bustard habitat.

(5) The Lala grasslands should be given the status of a Bustard Sanctuary. The area of the Sanctuary should be increased to include many unprotected grasslands in Bitta, Prajau, Bara, Tera, Sindrodi, Vanku and Kothara range. These areas are well known for healthy populations of Chinkara and Wolves. The coastal areas of Pingleshwar (about 15 km away from the proposed Lala Bustard Sanctuary) are very important for the nesting of the migratory and globally threatened Olive Ridley Turtles *Lepidochelys olivacea* which visit these coastal areas in thousands every year after the monsoon. If the Pingleshwar Turtle nesting areas are included in the Lala Bustard Sanctuary, it will enhance the value of the

sanctuary.

MANAGEMENT OF A TYPICAL BUSTARD SANCTUARY

All the bustard sanctuaries of India have some basic problems such as (i) expansion of agriculture and change in the land-use practices (ii) overgrazing by livestock and (iii) general disturbance to the bustard and its habitat by human activity. These problems are too well known to need any elaboration.

The following are some of the reasons why it is difficult to establish a large inviolable bustard sanctuary where human activity is not allowed.

a) Owing to the tremendous hunger for land in our rapidly growing population, it is impossible to develop a large bustard sanctuary of a few hundred square kilometre area exclusively for the bird. We simply do not have that much land to 'block' it from rational/traditional human use. Most of the bustard area is already occupied by man and it will be impossible to evict the local people. Moreover, even if we are able to develop a large bustard sanctuary in some remote corner of Kutch or Jaisalmer district where agriculture and grazing are totally eliminated, only a very small percentage of the total bustard population of the country can live in that sanctuary.

b) Secondly, the semi-nomadic nature of the bustard makes it difficult to confine the bird to a sanctuary. Bustards of Nannaj and Rollapadu are mainly seen in the grassland plots during the breeding season and during the rest of the year they roam around in a large area. In the absence of ringing and telemetry data their post-breeding movement is not known.

c) The bustard can survive in marginally cultivated areas; moreover limited or traditional cultivation provides it with an additional food source during certain months. Traditional agricultural practices in semi-arid regions create a mosaic of habitats which are used by the bustard. The bustard's survival in these areas can be further ensured by effective protection during its breeding season.

Taking into consideration the above factors, a typical bustard sanctuary should have two major components: (1) A very large buffer zone of a few hundred sq. km. where traditional agriculture and grazing should be allowed, and (2) small core areas of 100-500 hectares, protected from all interferences during the breeding season.

1. BUFFER ZONE

The buffer zone or size of the bustard sanctuary will depend on the suitability of the habitat.

As all areas having bustards cannot be declared sanctuaries, localities with the following optimum features should be given preference :

a) Low human and livestock populations; b) Less chances of future development and urbanization; c) Continuity of traditional cultivation in future; d) Reasonably good bustard population; e) Contiguity of the area with other bustard areas; f) Effective administrative, political and local support.

2. CORE AREA

The core areas should be the backbone of any bustard sanctuary. Success of Nannaj, Rollapadu, and Desert National Park have shown that development of core areas is extremely important for the successful breeding of the bustard. The main danger to the bustard in the breeding season is from human disturbance resulting in breeding failure. Thus the primary aim of the core area should be to provide disturbance-free sites to the bustards.

The core area should have the following features and functions:

i) **Size**: It should not be less than 100 hectares - the bigger the better.

ii) **Layout**: It should be as compact as possible in order to minimize disturbances at the periphery. The greater the boundary, the greater would be the chance of human/livestock disturbance to the bustard.

iii) **Site Selection**: The bustards show some site-fidelity with regard to their breeding and display grounds, hence the first objective should be to obtain information regarding areas where nests are generally found, and also the traditional display spots. Such sites should be preferably developed as the core areas.

iv) **Number and distribution**: The number of core areas will depend on (i) the total area of the sanctuary, (ii) availability of land, (iii) the number of bustards, (iv) sizes of different core areas, and (v) budget of the sanctuary.

Instead of having one large core area it would be better to have a number of smaller core areas dotted all over the sanctuary. For example, if 1000 ha is to be developed as a core area, then it is preferable to develop five plots of 200 ha each. The core areas should not be clumped together but they should be widely distributed in the sanctuary. This will have the following advantages: a) Create and protect more habitat types; b) Provide territories to more adult males; c) Create more nesting sites; d) In case of unavoidable habitat change/development near some core areas, atleast a few will remain unaffected.

v) **Fencing**: If the core area is between 100 and 200 hectares, it should be enclosed by Trench-cum-Mound (TCM).

The TCM should be as inconspicuous as possible and some bushes and grass should be planted on the mound. The trench should be about 1 m deep and 1.5 m wide to prevent entry of cattle. If the core area is more than 500 ha, as in the DNP, permanent chain-link fencing may be used. The fence should be 1 to 1.5 m tall.

vi) **Transition zone**: If the core area is small (*c*. 200 ha) then there should be a transition zone between the core area and the buffer zone. In the transition zone, only marginal cultivation should be allowed.

Functions of the Core Area: The main functions of the core areas are to provide undisturbed displaying, nesting, chick rearing and foraging facilities to the bustard. The following points will have to be considered in selection of the core area.

1. **Nesting requirements:** Well drained, slightly stony ground is ideal for nesting.

2. **Chick rearing:** Though bustard nests are generally found in comparatively open areas, once the chick hatches, it is taken to more vegetated parts of the habitat (Rahmani 1989a). Therefore, the core area should be maintained in such a way that one quarter or half is under tall grass (50-70 cm) and the remaining under low grass (20 cm).

3. **Display:** As reported earlier, preference should be given to develop core areas around traditional display spots. However, if it is not possible, then while demarcating a new core area, slightly undulating terrain should be selected which can provide a few elevated spots for the cock to display. If the terrain is uniformly flat then one or two artificial mounds, with very gentle gradient, should be created in the open patch of the core area. To avoid disturbance to the displaying bird, the mound should be atleast 200 m inside the boundary of the core area. The mound should be developed away from thickly vegetated areas because the bustard displays in areas from which it can have an unhindered view of its territory.

4. **Resting requirements:** Though the bustard prefers wide open areas for display, foraging and roosting, for resting it needs some shade (Rahmani 1989a). The core area should have some natural bushes (e.g *Acacia, Carissa, Euphorbia, Zizyphus*) or tall grass (e.g. *Sehima nervosum, Cymbopogon* sp.) for the birds to rest in during the hotter part of the day.

5. **Roosting requirements:** A typical bustard habitat generally has many open, bare patches which are used by the birds for night roosting. These are generally overgrazed areas. If such a micro-habitat is not present in the core area then artificial roosting spots should be provided by clearing away some vegetation. The roosting spots should be away from thickly vegetated areas to minimize chances of ambush by nocturnal predators. Atleast two or three roosting spots should be developed in every core area. One roosting spot should be developed near the display area.

6. **Foraging requirements**: If the core area is properly selected, developed and maintained, then the whole plot will be used for foraging. Quantity and quality of food in the core area will depend on the type of vegetation, degree of protection to the core area and the crop pattern of the region.

7. **Dust bathing requirements**: The bustard is very fond of dust bathing, especially during the breeding season (Rahmani 1989a). One or two spots can be maintained with loose soil. One dust bathing spot should be near the main breeding area.

Protection and Maintenance of Core Area: The success of any bustard sanctuary will depend on the protection and maintenance of the buffer zone and core areas. This involves (i) good administration and (ii) scientific habitat management.

ADMINISTRATION

1. Every sanctuary should have a Superintendent of the rank of Assistant Conservator of Forests.
2. The Superintendent should have a few rangers, assistant rangers, forest guards and watchmen. Forest guards and watchmen should be local personnel.
3. Proper vehicle and accommodation should be provided to all the staff members.
4. Forest guards and watchmen should not live in a colony but their houses/checkposts should be located in all the strategic corners of the sanctuary. This will be easy if they are recruited from different villages in the area.
5. Forest checkposts should be present at all the important entry points of the sanctuary. Regular checking of all the vehicles entering and leaving the area should be strictly enforced.
6. Licences for the so-called crop protection guns should be cancelled in and around the sanctuary.
7. From time to time, local leaders, village elders, religious heads and other important people of the area should be involved in reviewing steps for the protection of bustards. A few interested local people should be nominated as honorary wardens of the sanctuary. Special importance should be given to maintaining good public relations with the local people and the administration.
8. A certain percentage of the budget of the sanctuary should be set aside for the welfare of villagers such as construction of a Panchayat Bhawan (community hall) or a dispensary, free distribution of saplings of fruiting trees or construction of a bus shelter.
9. If the necessity arises to cut grass from the core area (see below), then this grass should be given free or at a nominal charge to the local people.
10. Proper compensation should be given to the affected parties if crops are damaged by wild herbivores. Population of wild herbivores should be kept under control either by shooting (in case of non-protected species like Wild boar *Sus scrofa*) or by trapping and translocation (in case of protected species such as Blackbuck).
11. In a suitable place in the sanctuary, a nature interpretation centre should be established, dealing with the ecology of the local flora and fauna. There should also be some visitor management within the sanctuary including the provision of simple hides for viewing. However, movement of visitors and their vehicles should be strictly regulated. The Andhra Pradesh Forest Department has developed an excellent nature interpretation centre in Rollapadu. Such centres should be present in all bustard sanctuaries.

Scientific Management: Once the core areas have been selected, protected and proper staff appointed, maintenance and management of the core area should be given top priority. Habitat management and monitoring the bustard population should be done regularly.

Habitat Management: As has been repeatedly emphasised, the bustard prefers treeless, open areas with short grass and a few scattered bushes

(Ali & Ripley 1983, Dharmakumarsinhji 1957, Rahmani 1989a). Therefore, the core areas should be maintained as a grassland. As the grasslands in India are at the pre-climax stage (Champion & Seth 1968), grazing, fire or cutting is necesary to maintain them. With complete protection, the grassland soon turns into dense scrubland and finally into forests. Therefore, to maintain the grassland, the following steps should be taken in the core areas.

1. ***No tree planting:*** No trees should be planted in the core area. Only natural growth of local trees should be allowed but if the growth becomes dense or some trees become tall (above 3 m) they should be trimmed.

However, owing to earlier over-use if there is no bush or shrub left in the core area, then some species like *Acacia leucophloea, Salvadora, Zizyphus rotundifolia* and *Carissa* sp. may be planted in the low-lying parts of the core area. These species should not be planted on ridges or near the display and roost sites. Before deciding to introduce any species in the core area, a time lapse of 2-3 years should be given to see whether bushes or trees come up naturally. Only when the natural regeneration is slow can some bushes or trees be introduced. Care should be taken that no exotic or commercial species like *Eucalyptus, Casuarina, Prosopis* or *Leucaena leucocephala* is introduced in the core area.

It should be remembered that it is better to have fewer trees and bushes in the core area than to have too many.

2. ***Maintenance of grassland:*** As the precipitation in most of the bustard areas is low, the grass generally does not grow very tall. However, at places like Karera and Ghatigaon, due to edaphic factors sometimes the grasses grow dense and tall (about 1 m) which is not preferred by the bustard. Similarly, in Maharashtra and Andhra Pradesh areas, with the complete stoppage of grazing, tall grasses like *Sehima nervosum* come up. Though *Sehima nervosum* is useful in the protection of the chick, it hinders foraging and display activities. In the Desert National Park Sewan grass (*Lasiurus sindicus*) has covered many core areas. In such cases, thinning, cutting or limited grazing would be useful to maintain the grassland at the optimum suitability for the bustard.

a) *Grass cutting:* Limited grass cutting by local inhabitants at nominal charge should be allowed only if the grass has become tall (above 1 m) and dense. Grass cutting should be carried out strictly under supervision and between 1000 hr to 1600 hr to minimize disturbance to the bustard. In those places where the bustard is not resident, grass cutting (or grazing) should be allowed only when the birds have left the area. Cutting (or grazing) should start only after one month of the breeding season.

b) *Limited grazing:* Grazing should be strictly limited and only local people should be allowed to graze their livestock. Preference should be given to those people who have land or fields adjacent to the core area. Once they are benefited, they will develop an interest in protecting the core area. Non-resident graziers should never be allowed in the core area.

Like grass cutting, limited grazing should also be allowed only after the breeding season. As a policy, only cattle should be allowed inside the plot and not the herdsmen as the bustard is not much disturbed by unmanned livestock. Sheep and goats should never be allowed inside the core area.

c) Time of grazing: The time of grazing should be between ten to four and not during early mornings and evenings when the bustard is most active. Only a limited area (*c.* 25%) of the plot should be opened for grazing at a time to leave some undisturbed areas for the birds.

d) Dung collection: In order to enrich the soil, dung picking should not be allowed inside the core area.

e) Cooperation of local people: Both grass cutting and grazing should not be allowed at the same time. Local people should be consulted before starting grazing or grass cutting.

f) Non-commercial harvest of grass: It should be kept in mind that the main purposes of allowing limited grazing or grass cutting is to make the habitat suitable for the bustard and to help the local people. It should not become a commercial activity of the Forest Department under any circumstances.

There should be strict adherence to the duration of grass cutting/grazing. In the present Indian conditions, it is very difficult to control the number of livestock as it involves daily checking and a very high degree of integrity of watchmen. Therefore, it is easier to limit the duration of grazing/grass cutting time to two or three months. This will depend upon the grass growth, grass type, size of the core area, livestock pressure, cooperation of the local people, and most importantly, on the managerial skill of the custodians of the sanctuary.

Population Monitoring: A yearly census of the bustard in all the core areas and the buffer zones of the sanctuary should be done. As the bustard has a tendency to flock during rains, the census should be done during the peak rainy season. Days with overcast sky or with a slight drizzle are best for census. Early mornings or evenings would the best time and all the plots should be surveyed simultaneously.

The maximum number of bustards sighted in any given area should be noted every year. This will indicate the population trend as well as the rate of colonization of a particular core area. Preferably, the same date or week should be selected every year for census.

The number of cocks, hens, and if possible juveniles should be noted separately. The number of displaying (territorial) males should also be noted. Basic data such as nest sites, number of eggs located every year and number of chicks hatched should be noted.

Precautions: (1) The duties of a forest guard or watchman should be to protect the core area. Not much emphasis should be given to searching a nest and protecting individual nests. If the habitat is undisturbed, the bustard will successfully breed and raise the chick. They existed for millions of years without our 'help' and they can do so for many more years if we do not disturb them and their habitat. However, if a nest is found in a private field or in an unprotected area, the watchman should see that the egg is not trampled by livestock or picked up by villagers.

2) If an egg is found presumably unattended, it should never be collected for artificial incubation or for showing it to the superiors in the department. The bustard rarely abandons the nest and if the hen is not seen, it does not mean that she has deserted the nest. She will come back as soon as the intruder leaves.

(3) Visitors, irrespective of their status, should not be shown nests nor their locations. There is nothing special about a bustard egg except that if allowed to be incubated, it adds one more individual to the population of this rare species.

PROJECT BUSTARD

Four species of bustards are found in India: Great Indian Bustard, Houbara Bustard, Lesser Florican *Sypheotides indica* and Bengal Florican *Houbaropsis bengalensis*. They all live in grasslands or arid open areas. The Houbara bustard is a winter migrant, mainly seen in the Thar desert from November to March. The three resident species of bustards are highly endangered, with none of them having a population of more than 3,000. Attempts have been made to conserve these endangered birds but there is no coordinated effort among different states. It is now necessary to start a nationally-coordinated project, on the lines of Project Tiger and Project Elephant, to protect the Great Indian Bustard, the two floricans (Lesser and Bengal), Houbara bustard and other inhabitants of Indian grasslands.

There are many reasons to have a nationally coordinated conservation project for Indian bustards and their habitats. Important reasons are given below:

1. Need for cooperation: Each state is taking its own course of action to conserve bustards and floricans without knowing what the other states are doing. There is no cooperation among the states even though the bustards and floricans move from one state to another. In some cases, officials of one state do not even know that the same bustard species is found in other states also!

2. Need for better management of sanctuaries: After the initial enthusiasm to protect bustards in the early 1980s, with most attention on the Great Indian Bustard, in many cases sanctuaries have been neglected as a result of which bustard populations have declined. Establishment and maintenance of some of the bustard and florican sanctuaries were mainly due to active interest taken by some individuals such as Ranjitsinh, J. J. Dutta, P. M. Lad, Pushp Kumar, Kailash Sankhala to mention a few. Once such people retired or were shifted to other departments, conservation of bustards and floricans received a setback [e.g. Karera, Ghatigaon, Sailana (for Lesser florican), Sonkhaliya are now neglected].

3. Research and implementation of findings: Little work has been done on the ecology and behaviour of the bustards, except for the work done under the Endangered Species Project of the Bombay Natural History Society. Bustard and florican populations need constant monitoring. Moreover, conditions in some sanctuaries are changing so fast that by the time the results are published, the situation is completely different. Worse, there is no authority or mechanism at present to supervise the follow-up action on the recommendations of scientific studies.

4. Long-term plan: There is no proper long-term planning to protect bustard habitats (except perhaps in the Bengal florican areas, but that is done for other reasons). As the Great Indian Bustard lives in marginally agricultural areas and Lesser Florican is seen in many private grasslands, a greater administrative and scientific input is required to keep the habitat suitable for bustards and floricans.

5. Protection to associate species of bustards: By starting Project Bustard, grassland habitats and their associated species such as Indian Wolf, Jackal *Canis aureus*, Indian Fox *Vulpes bengalensis*, Desert Fox *Vulpes vulpes*, Chinkara, Blackbuck, Swamp deer *Cervus duvauceli*, Swamp Francolin *Francolinus gularis*, raptors, coursers, etc, will greatly benefit.

Taking into consideration all these factors, the Government of India should start 'Project Bustard' with the following objectives:

1. To conserve all the four species of bustards in India; 2. To conserve the habitat types of Indian bustards and their associate species; 3. To establish, more bustard sanctuaries with the cooperation of state governments; 4. To upgrade the existing closed areas to wildlife sanctuaries; 5. To supervise and coordinate management of bustard sanctuaries; 6. To coordinate long-term studies on bustards and their habitats in different areas; 7. To integrate grassland (bustard habitat) conservation with national grazing policy.

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DISTRIBUTION, STATUS AND CONSERVATION OF INDIAN HERONRIES

S. Subramanya[1]

(*With four-text figures*)

The current state of knowledge on the colonial waterbird nesting sites (heronries) in India is presented. The information gathered on over 533 nesting sites of 26 species of Pelecanidae, Phalacrocoracidae, Ardeidae, Ciconiidae and Threskiornithidae indicate a distinct concentration of 360 existing sites in southern India, western and north central India and Assam in the Northeast. Of the species considered, Little Cormorant, Night Heron, Pond Heron, Cattle Egret and Little Egret were the most common nesting species in the heronries. Available information showed the existence of variation in the number and type of species nesting in different states of India. Analysis of the habitats in which the nest sites occur indicated that nearly 53% of the existing sites were found within or close to human habitation. While only a few sites have been in existence from well over a century, a number of sites were found to have come into existence in the last five decades. Over the last century, about 173 sites have been lost for several reasons. Only a small proportion of the existing heronries were found in protected areas. Several large heronries in India have been identified and the study has enabled us to understand how heronries come into existence. The existing sites are prone to a number of threats and disturbances and the influence of natural calamities. The current status and future options for conservation of heronries in India are discussed.

INTRODUCTION

The habit of nesting colonially is an important feature among a majority of the members of Pelecaniformes and Ciconiiformes (Ali and Ripley 1987, Burger 1981, Krebs 1978). A majority of species representing these two groups in India are known to nest colonially (Ali and Ripley 1987). The nesting colonies of these birds that represent spatial and temporal clumping of nests are popularly referred to as heronries. The information available on such heronries in India pertains mainly to a few regional studies (e.g. Mahabal 1990, Nagulu and Rao 1983, Naik *et al.* 1991, Naik and Parasharya 1987, Parasharya and Naik 1990, Santharam and Menon 1991, Sharatchandra 1980, Singh and Sodhi 1986), several site specific studies (e.g. Chaudhari and Chakrabarti 1973, Datta and Pal 1990, 1993; Gee 1960, Nagulu 1983, Neelakantan 1949, Neginhal 1983, Paulraj 1984, Ragunatha 1993, Ragunatha *et al.* 1992, Sanjay 1993, Subramanya *et al.* 1991, Subramanya and Manu 1996, Urfi 1989c, 1990, 1992, 1993a, 1993b; Vijayan 1991) and a number of site records (e.g. Abdulali 1962, Ali 1960, Baker 1935, Barnes 1886, 1891; Barooah 1991, Bates and Lowther 1952, Badshah 1963, Betham 1904, Bingham 1876, Bhat *et al.* 1991, Bolster 1923, Chhaya 1980, Daniel 1980, Ganguli 1975, Hume 1881, Jamgaonkar *et al.* 1994, Naik 1987, Neelakantan and Elamon 1984, Packard 1903, Subramanya 1993, Urfi 1992, Uttaman 1990, Webb-Peploe 1945, Wilkinson 1961). Despite the availability of such an information base on heronries in India, no concerted effort has been made so far to determine their distribution, status and conservation needs. Even an earlier attempt by Betts (1937) in this direction was not fruitful. This paper is an effort towards bridging this gap in Indian ornithology and presents an overview of the information gathered as part of a much larger project (Subramanya, unpublished).

METHODS

Between 1993-95, questionnaires requesting information on heronries were sent to over 700 birdwatchers, ornithologists and naturalists in different parts of India (Subramanya 1993). Details on location, breeding season, status, nesting site, colony size, species breeding at the site and the available published information on heronries were collected from contributors. Habitually solitary nesting species (Black Ibis, *Pseudibis papillosa* and Whitenecked (Woolly-necked) Stork, *Ciconia episcopus*) found nesting in heronries were also included in the study. Thus, 26 species (Table 1) were considered in the survey. Details on some active sites and those that once existed within Indian limits were obtained through published literature.

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The available data on the number of heronries in which each of the 26 nesting species were nesting and the abundance of heronries in different Indian states were subjected to cluster analysis (Ludwig and Renolds 1988), to group species with similar dispersal patterns.

The nomenclature follows Ali and Ripley (1987) and Sonobe and Usui (1993). All the abbreviations of species mentioned in the tables are as per Table 1. The details of some of the heronries are presented in Appendix I.

RESULTS AND DISCUSSION

Abundance of Nesting Species: The questionnaire survey and review of literature yielded information on 360 active sites. The number of sites in which each of the 26 species nesting in heronries have been recorded, is presented in Fig 1. Of the 26 species considered, Little Cormorant, Night Heron, Pond Heron, Cattle Egret and Little Egret were the most abundant nesting species in Indian heronries and were found nesting in over 100 sites. The most common nesting species in Indian heronries was the Little Egret which nests in about 150 sites. The Spotbilled Pelican, Lesser Adjutant, Greater Adjutant and the Glossy Ibis were found to nest in less than 20 heronries (Fig. 1).

Among the 26 species considered, the Little Cormorant, Night Heron, Pond Heron, Cattle Egret and the Little Egret were the most abundant nesting species in Indian heronries (Fig. 1). Glossy Ibis which was known to breed in Lucknow (Oude), Orissa, and Assam (Baker 1935), was found nesting only at the Luna village, Banni grassland in the Kutch region (Tiwari 1993 and pers. comm.) and at the Panidihing Heronry in Assam (D. Barooah, P. Kumar Saikia & Anwaruddin Choudhury, pers. comm.). Baker (1935) recorded colonies of Chinese Egrets at North and South Lakhimpur, Tinsukia Railway Station and Dhimaji town. The present survey has

TABLE 1
DETAILS OF SPECIES CONSIDERED IN THE HERONRY SURVEY

Species details	Code
PELICANIFORMES	
PELECANIDAE	
Great White (Rosy) Pelican *Pelecanus onocrotalus*	GWP
Spotbilled Pelican *P. philippensis*	SBP
PHALACROCORACIDAE	
Great Cormorant *Phaldcrocorax carbo*	GC
Indian Shag *P. fuscicollis*	IS
Little Cormorant *P. niger*	LC
Oriental Darter *Anhinga melanogaster*	OD
CICONIIFORMES	
ARDEIDAE	
Night Heron *Nycticorax nycticorax*	NH
Pond Heron *Ardeola grayii*	PH
Chinese Pond Heron *A. bacchus*	CPH
Cattle Egret *Bubulcus ibis*	CE
Western Reef Egret *Egretta gularis*	WRE
Eastern Reef Egret *Egretta sacra*	ERE
Little Egret *E. garzetta*	LE
Smaller Egret *E. intermedia*	SE
Great Egret *E. alba*	GE
Purple Heron *Ardea purpurea*	PrH
Grey Heron *A. cinerea*	GH
CICONIIDAE	
Painted Stork *Mycteria leucocephala*	PS
Asian Openbill *Anastomus oscitans*	OBS
Woolly-necked (White-necked) Stork *Ciconia episcopus*	WNS
Lesser Adjutant Stork *Leptoptilos javanicus*	LA
Greater Adjutant Stork *L. dubius*	GA
THRESKIORNITHIDAE	
White (Black-headed) Ibis *Threskiornis melanocephalus*	BHI
Black Ibis *Pseudibis papillosa*	BI
Glossy Ibis *Plegadis falcinellus*	GI
White Spoonbill *Platalea leucorodia*	WSB

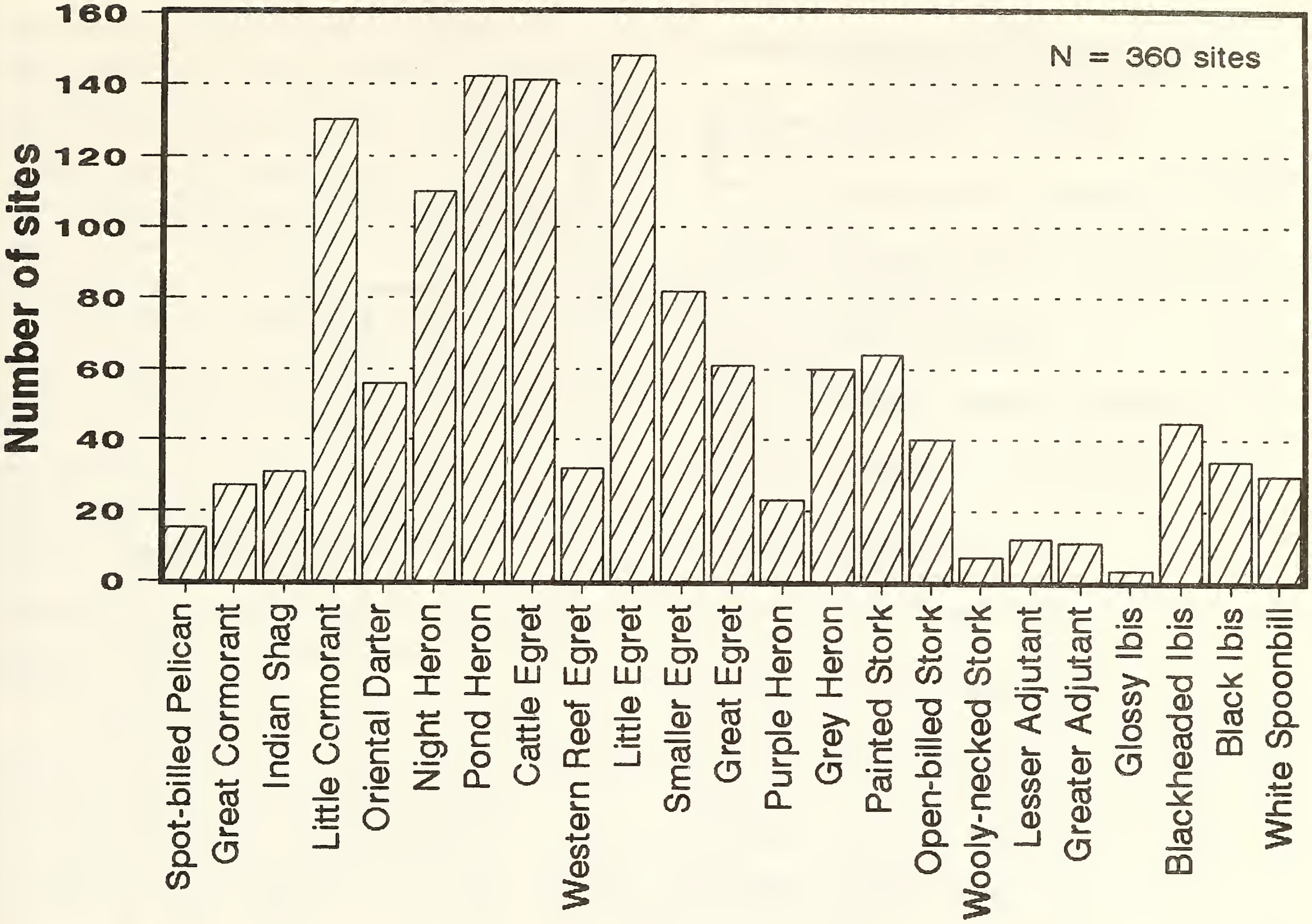

Fig. 1. Number of sites recorded for different bird species nesting in heronries.

only revealed suspected nesting of the species at the Panidihing Heronry (Diptimanta Barooah, pers. comm.). But for nesting prior to 1930s (Hume and Oates 1890, Baker 1935), no recent information on the nesting colonies of the Eastern Reef Egret is available. Similarly, information could not be obtained on the present status of the nesting colony of Great White Pelican visited by Ali (1960) and Shivrajkumar *et al.* (1961).

An analysis of the frequency and distribution of bird species currently nesting in heronries across different states revealed four distinct groups (Fig. 2). While the Little Cormorant, Pond and Night Herons, Cattle, Little, Smaller and Great Egrets were the most widespread nesting species in India, the group with highly restricted distribution of species included Spotbilled Pelican, Greater and Lesser Adjutant Storks, Whitenecked (Woolly-necked) Stork, Glossy Ibis and the Western Reef Egret. The group with partly restricted distribution included the Great Cormorant, Purple Heron, Indian Shag, Oriental Darter and the Black Ibis. The rest of the species were part of the less widespread group (Fig. 2).

Distribution of Heronries: Mapping of the heronries in India indicated a distinct concentration of sites in southern India, western and north central India and Assam in the North-east (Fig. 3). Also, the distribution of heronries within India indicated a clear concentration along the coasts and coastal plains, arid and semi-arid regions, Brahmaputra floodplain (with the exception of Ganges floodplain) and Western Ghats. Central India, south of the Himalayas, eastern India including interior Orissa and West Bengal appears to be impoverished of these nesting sites. The notable absence of heronries in

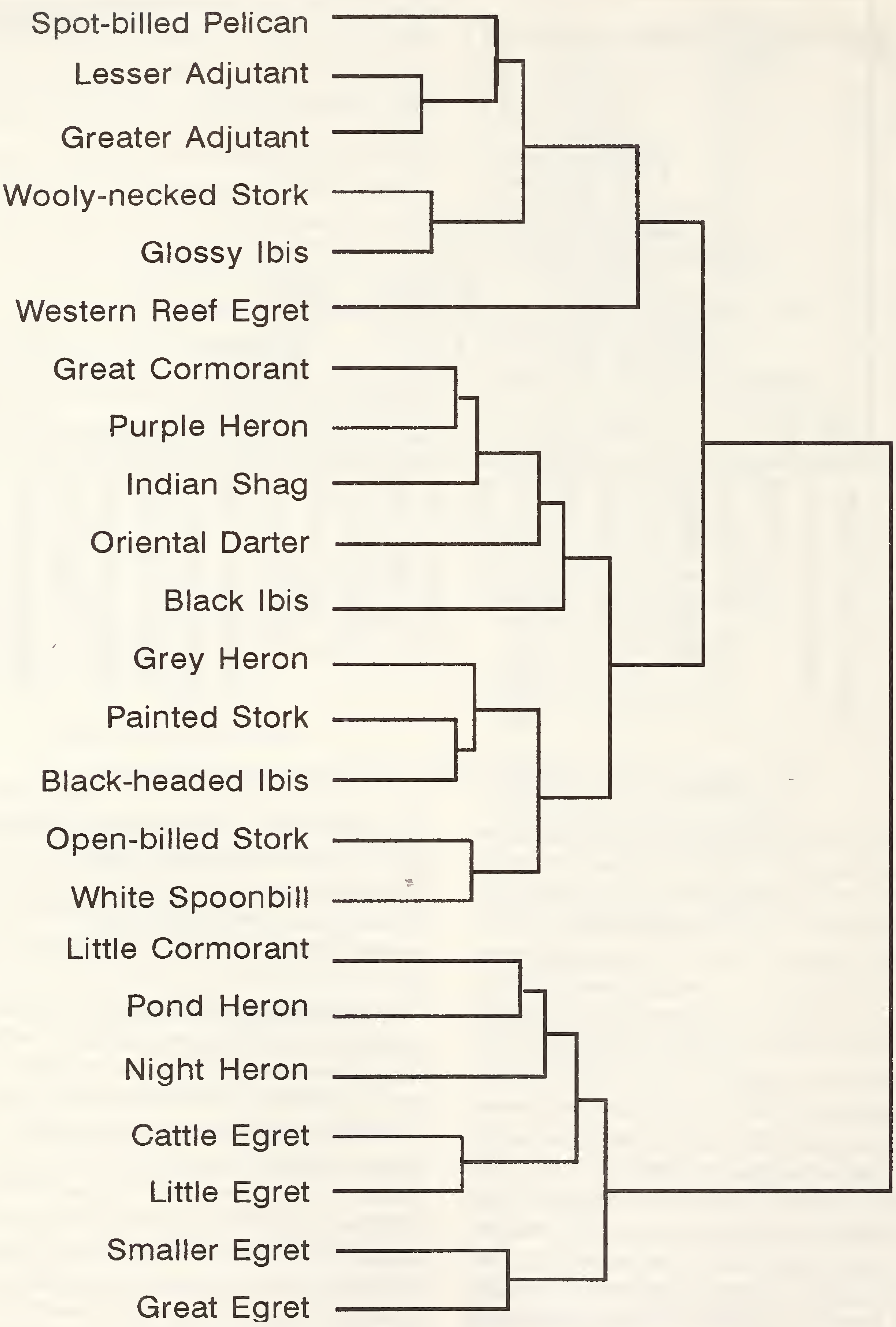
Spot-billed Pelican
Lesser Adjutant
Greater Adjutant
Wooly-necked Stork
Glossy Ibis
Western Reef Egret
Great Cormorant
Purple Heron
Indian Shag
Oriental Darter
Black Ibis
Grey Heron
Painted Stork
Black-headed Ibis
Open-billed Stork
White Spoonbill
Little Cormorant
Pond Heron
Night Heron
Cattle Egret
Little Egret
Smaller Egret
Great Egret

Fig. 2. Grouping of different bird species based on their nesting distributions in different parts of India.

these regions, especially in the Gangetic plain, is quite surprising. It is also possible that efforts have not been made to look for heronries in this region despite their existence. Only a concerted search for nesting sites will reveal the true status. In fact, intensive searches have revealed the occurrence of a large number of heronries in a given region. The 14 heronries seen at the Raigad district, Maharashtra (Mahabal 1990), and the 44 nesting sites of Cattle and Little Egrets found in the Kharar tehsil of Ropar district in Punjab (Singh and Sodhi 1985) indicate that often, in intensely cultivated areas, the density of heronries can be appreciably high. On the other hand, these areas may be truly impoverished. In Bihar, for example, it is very difficult to find nesting sites of colonial waterbirds or for an active site to exist for long, as most of them are destroyed by local people out to secure easy meat and eggs (S.A. Hussain, pers. comm.).

The occurrence of heronries in a particular region is dependent on the availability of suitable feeding conditions for waterbirds (Bancroft *et al.* 1988, Carrascal *et al.* 1993, Gibbs *et al.* 1987). Thus, a comparison of the distribution of wetlands censused during the Asian Midwinter Waterfowl Census (Perennou *et al.* 1994) and the distribution of heronries indicate that the occurrence of heronries closely follows the distribution of wetlands where they feed. When one considers the types of wetlands that occur in different parts of India (Perennou and Mundkur 1991, 1992; Perennou, Rose and Poole 1990, Scott and Rose 1989, van der Ven 1987, Hussain and Roy 1993), it appears that in central and eastern Gujarat, eastern Rajasthan and in the whole of Deccan Plateau, excluding the coastal regions, the heronries are mainly dependent on man-made waterbodies like tanks and large reservoirs. In the Deccan Plateau, a large number of man-made inland irrigation tanks play an important role in providing ideal feeding conditions to waterbirds (Subramanya 1990, Sampat 1993) and also in supporting a number of heronries (Table 2).

There is a dense concentration of heronries along the east and west coasts of India. Coastal wetlands like lagoons, backwaters, estuaries, mangroves, mud flats, etc. occurring within about 35 km from the coasts seem to have a strong influence on the distribution of nesting sites along the coasts. Similarly, in the Southern Gulf of Kutch coastal wetlands (Naik *et al.* 1991) and in Assam, the Brahmaputra floodplain, with its associated beels, provides important feeding areas for the colonial nesting waterbirds (Baker 1935).

TABLE 2
SITES PREFERRED BY COLONIAL NESTING WATERBIRDS IN INDIA*

Type of nesting sites	Per cent Frequency
Trees in villages	23.87
Trees in towns/cities	23.37
Trees in fresh waterbodies	11.06
Trees close to fresh waterbodies	11.32
Wooded areas	8.04
Trees near habitations	5.28
Trees in Coastal area	3.77
Reedbeds	3.52
Trees on Coastal islands	3.52
Trees on islands	3.27
Tree stumps in reservoirs	1.51
Trees among cultivations	1.26
Trees in aviaries	0.26

*N = 354 sites

Nesting Habitats: The nesting sites of the 26 species of colonially nesting waterbirds have been recorded to occur in as many as 13 different habitat types. The frequency distribution of such nesting sites is presented in Table 2. Nearly 53 % of the observed nesting sites were found either within or close to human habitations. Only about 31 per cent of the sites were found to occur within or close to fresh water bodies. Around 7% of the sites were found in coastal areas and coastal islands: Reed-beds were one of the preferred nesting substrate once, as at Brahmaputra Valley (Baker 1935, Hume and Oates 1890) and Kashmir (Bates 1929). Only a few such reed-bed nesting sites have been reported. In about eight per cent of the sites, heronries were located within or close to wooded areas, as at Raiganj in the West Dinapur district of West Bengal (Datta and Pal 1990, 1993; Shahi 1983).

Several nesting colonies of the Great

TABLE 3
DETAILS OF HERONRIES FOUND INSIDE LARGE RESERVOIRS

Name of the Reservoir	State	District	Nesting Species	Source*
Kabini Backwaters	Karnataka	Mysore	GC, OD	Ullas Karanth
Mandagadde		Shimoga	LIC, IS, OD, NH, PH, LE, SE, GE, PrH, BHI, WSB	S.G. Neginhal; Subramanya, 1993
Attiveri		Uttara Kannada	IS, LC, OD, CE, PS, NHI, WSB	P.D. Sudershan; R. N. Desai
Periyar Wildlife Sanctuary	Kerala	Idukki	GC, OD, WNS	Jafer Palot; Thomas Nelson
Chimmoni		Trichur	GC, IS, LC, OD, PH, PS, WNS, WSB	E.A. Jayson, P.S. Easa & P.V. Prabhakaran; J. Praveen
Parambikulam		Palakkad	GC, LC, NH, GH	Sabel Martinaz & Andy Eliott
Upper Glenmorgan Headworks	Tamil Nadu	Udagamandalam	GC	Manoj V. Nair; Nair 1996
Kota Dam	Rajasthan	Kota	NH	R.G. Soni

* Names refer to information obtained through personal communications

Cormorant and Darter are found on dead tree trunks partially submerged in water in the backwaters of large reservoirs (Table 3). The partially submerged tree trunks became available to the birds, subsequent to the submergence of forest in river valleys. The most unusual record was at the Kota Dam in Rajasthan, where Night Herons which usually prefer the seclusion of a dense tree canopy for breeding (Baker 1935, Ali and Ripley 1987), were nesting openly on exposed tree trunks (Soni 1992).

Site Tenacity: Affinity to nest at a site or close to a site where they previously nested appears to be very strong among colonial waterbirds. At sites where they have enjoyed long years of protection, birds exhibit intense site tenacity. However, their continued nesting at the site even after a disaster appears to depend on the extent of damage to the nesting substrate and the availability of alternate nesting substrate at the site. When flash floods ravaged Ranganathittu Bird Sanctuary during 1991, over 1500 nests were swept away by the surging waters, but the birds started re-nesting once the floods abated (Subramanya *et al.* 1991). When the preferred nesting tree was cut down by villagers at Mathikere Heronry in Karnataka, the birds nested on nearby trees which had not been used. Similarly, when the Neem tree on which Openbill Storks were nesting at Tsunduru Village in Andhra Pradesh was affected by a cyclone in 1990, the birds successfully shifted over to nest on *Polyalthia longifolia* (K. Mruthunjaya Rao, pers. comm.).

Since the availability of a suitable feeding site is an important consideration for the choice of a specific site, the intense site tenacity showed by nesting species is an indication that their feeding habitats in the surrounding area are intact. Birds do not appear to shift to a new locality or abandon the site unless alternate nesting substrate is available. In such situations, total destruction or uprooting of all the available nesting substrates at the site forces the nesting population to shift to an alternate site close by as seen at Jagrugumilli Village Heronry in Prakasham district, Andhra Pradesh. After a devastating cyclone in 1979, the birds nesting at

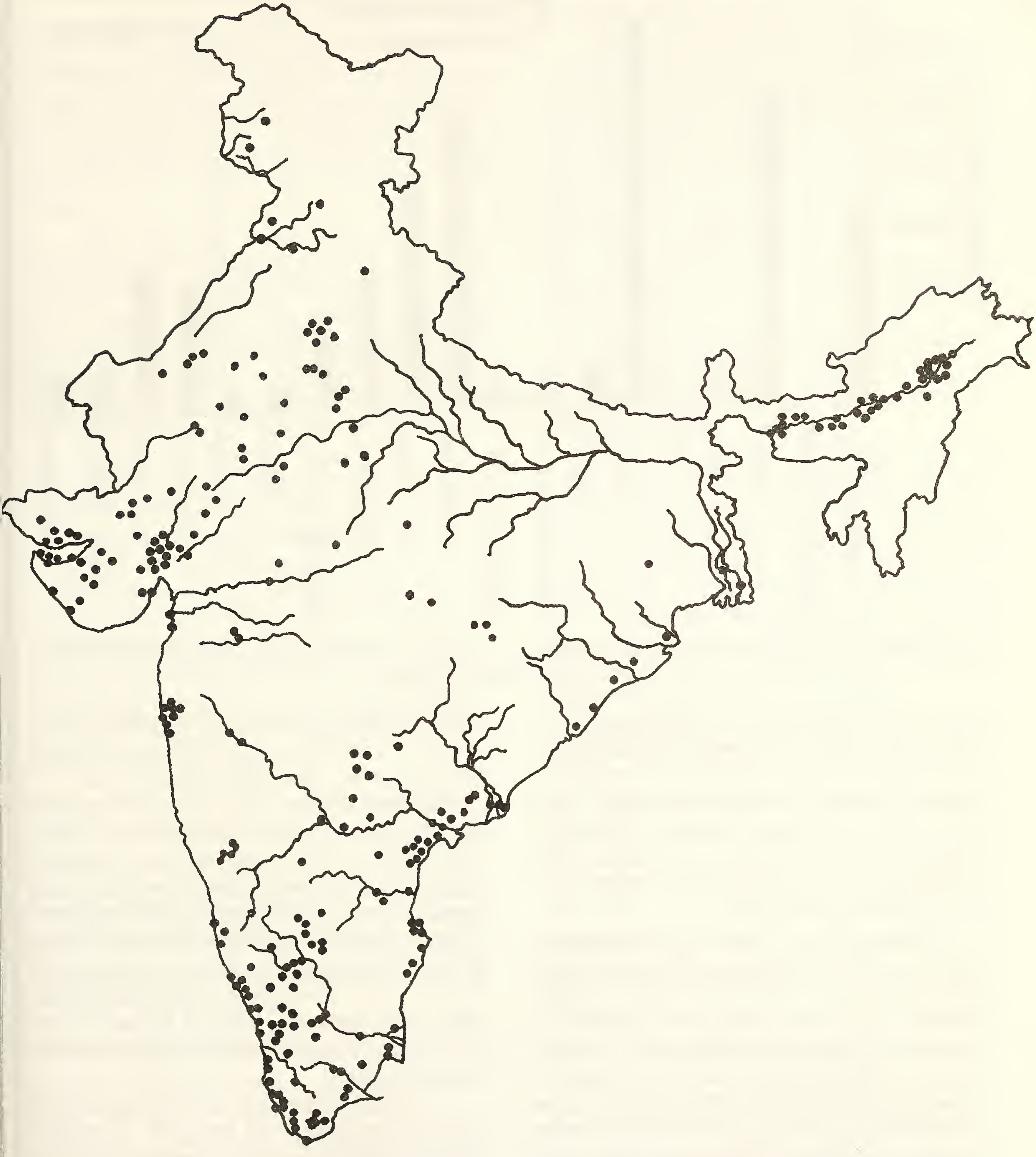

Fig. 3. Distribution of heronries in India.

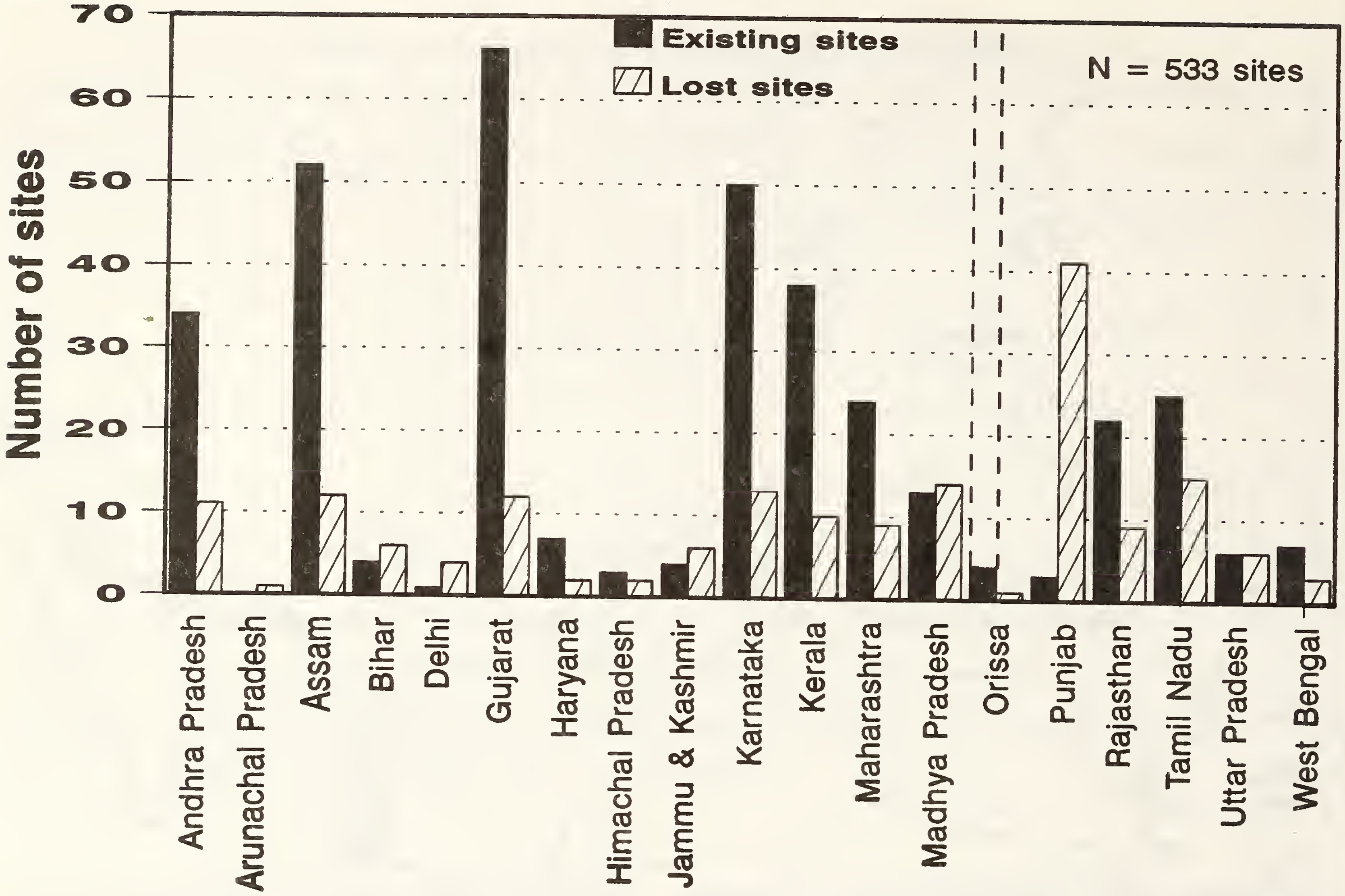

Fig. 4. Number of existing and lost heronries in different states of India. Hatched histogram indicates the number of sites known to exist in Orissa.

Jagrugumilli Village Heronry shifted to Patchava Village about 8 km away, when alternate nesting substrates were not available. Similarly, a thunderstorm destroyed the crown of an *Acacia nilotica* tree in Cuddapah city during 1989 and the Pond Heron, Cattle Egret and Little Egrets which were nesting on the tree regularly, abandoned the site (Riazuddin, pers. comm.).

Existing Sites: Details of the number of heronries recorded in 18 Indian states and one union territory is presented in Fig. 4. Though the figure pertains to the information that was sent by contributors, there could still be a large number of heronries which have not yet been located by birdwatchers or heronries on which information was not shared. For example, with the assured feeding opportunity available at Chilka Lake in Orissa, every village located around the lake is known to have a small to medium sized heronry (Sudhakar Kar, pers. comm.). Similarly, within Mysore District, Karnataka, every tank supporting a dense patch of bulrush reeds (*Typha* sp.) is known to invariably contain one or two nests of Purple Heron (K. Manu, pers. comm.). However, with the available information, it was found that Gujarat supports the largest number of heronries in India (68 known sites) followed closely by Assam and Karnataka (around 50 sites) and Kerala with 38 sites. Less than ten heronries were recorded in Arunachal Pradesh, Bihar, Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Orissa, Punjab, Uttar Pradesh and West Bengal (Fig. 3).

All the Adjutant Stork colonies are located in Assam (Changkakati and Das 1991, Choudhury 1993, Raj 1990, Saikia and Bhattacharjee 1990a, b). Though the Lesser Adjutant was once known to nest in Kerala (Travancore) and parts of Malabar coast in the south-west, east coast, Orissa and Assam (Baker 1935), the nesting of Lesser Adjutant at the Bhitarkanika Wildlife Sanctuary is the only recent record of the species nesting outside north-eastern India (Pandey 1993). The recent reported nesting of the Black Stork *Ciconia nigra* (Datta 1996) is the first ever record of the species nesting within Indian limits.

The bulk of the nesting colonies of Western Reef Egrets are found in Gujarat where they nest in coastal area, coastal cities and coastal islands (Ali 1945, 1954; Naik 1991, Naik *et al.* 1991, Naik and Parasharya 1987, Parasharya and Naik 1990, Ranjitsinh 1985, Taej Mundkur and Lavkumar Khacher, pers. comm.). Hitherto, the colony near Nellore (Kirkpatrick 1961) was the only known nesting site of the species on the east coast. This site is no longer active. The present survey has brought to light two unknown nesting sites of the species on the east coast in Andhra Pradesh located at the Coringa Wildlife Sanctuary (Ashok Kumar; V. Vasudeva Rao and V. Nagulu, pers. comm.) and the Lankivanidibba of Repalle range of Krishna estuary (Narendra Prasad, pers. comm., Prasad 1992). It is quite possible that more of these sites may exist on the east coast and on the west coast, south of Gujarat. Only a determined effort to locate additional nesting sites may reveal their existence.

The present survey has revealed that the Spotbilled Pelican breeds in about 15 sites distributed over Andhra Pradesh, Assam, Karnataka and Tamil Nadu (Subramanya, unpublished). Considering this, the report of the presence of only four colonies of the species in India in 1982 (Crivelli and Schreiber 1984) is incorrect as at least ten of the present nesting sites have been active for well over two decades (Subramanya, unpublished).

Of the existing heronries, some of the colonies are known to be active since several decades or even centuries (Table 4). However, very few such sites exist today and the main reason for their survival is the quality of protection they have enjoyed in the locality, either by State Forest Departments or through the sentiments of the local people. The list of some of these active sites shown in Table 4 is by no means complete and needs updating.

Reference to heronries prior to re-organisation of Indian states abounds in Indian ornithological literature. However, it is difficult to confirm their present day locations. For example, the large heronry with thousands of nesting birds located half-way between a place known as Tangalle and Mathura (Matura) referred to by Hume and Oates (1890), could well be the present day Keoladeo National Park. There appears to be little doubt that the pelicanry visited by Jerdon (1864) in Karnataka (Carnatic) is the present day Kokkare Bellur Pelicanry, where Spotbilled Pelicans nest in association with Painted Storks on trees in the middle of a village (Nagulu and Rao 1983, Neginhal 1976, 1993; Sanjay 1993).

Searching for some of the old heronries could be a tedious task. Nevertheless, given time and effort, the present day status of these sites can be known. Baker (1935) had visited an extremely large Great Cormorant colony of over 3000 pairs located on the rocky banks of Subansiri River several kilometres before it debouches into the plains. Recent searches have revealed that the colony exists even today, but only a small number of birds nest at the site (Anwaruddin Choudhury, pers. comm.).

Large heronries in India: The number of birds nesting in heronries varies greatly and only a few sites qualify to be considered as large heronries. Table 5 lists the top ten heronries in India where over 5,000 pairs or nests have been recorded. However, this list is far from complete and needs updating.

Traditional nesting sites: Heronries where birds return each year to breed regularly become traditional nesting sites. As the availability of suitable feeding conditions in the surrounding area and safe nesting sites in the locality are the two factors governing the occurrence of heronries (Bancroft *et al.* 1988, Carrascal *et al.* 1993, Gibbs *et al.* 1987, Parasharya and Naik 1990), continued survival of these nesting sites is an indirect indication that the feeding areas of nesting birds are in a healthy state. As a consequence, birds return to such sites year after year. Table 6 lists some of the traditional nesting sites

TABLE 4
SOME OF THE OLDEST INDIAN HERONRIES STILL ACTIVE IN INDIA

Name of the heronry	State	District	Nesting species	Year of earliest record	Source*
Subansiri Colony	Arunachal Pradesh	Upper Subansiri	GC	1930s	Baker, 1935
Neelapattu	Andhra Pradesh	Nellore	SBP, LC, LE, GH, OBS, BHI, WSP	1983	Nagulu, 1983, Nagulu and Rao, 1983
Telineelapuram	Andhra Pradesh	Srikakulam	SBP, PS	1983	Nagulu and Rao, 1983
Ethirapattu	Andhra Pradesh	Nellore	LC, LE, PS, WSB	1983	Ramakrishna, 1986, V. Nagulu & Joel Prashanth
Kaziranga Pelicanry	Assam	Golaghat	SBP	1950s?	Anwaruddin Choudhuri
Kokkare Bellur Pelicanry	Karnataka	Mandya	SBP, PH, PS, BHI	1860s	Neginhal, 1976, 1993; Sanjay, 1993
Ranganathittu Bird Sanctuary	Karnataka	Mysore	GC, IS, LC, OD, NH, PH, CE, LE, SE, GE, PrH, GH, PS, OBS, BHI, WSB	1930?	Ali, 1943, Neghinhal, 1983
Gudvi Bird Sanctuary	Karnataka	Shimoga	IS, LC, OD, NH, PH, LE, SE, GE, PrH, BHI, WSB	1800s?	Ragunatha, 1993, Ragunatha *et al.*, 1992
Periyar Wildlife Sanctuary	Kerala	Idukki	GC, OD, WNS	1900?	Jafer Palot
Kumarakam	Kerala	Kottayam	GC, IS, LC, OD, NH, PH, LE, SE, GE, PrH	1980s	Sreekumar; Neelakantan & Elamon, 1984
Bhitarakannika Wildlife Sanctuary	Orissa	Cuttack	LC, OD, NH, SE, PrH, GH, OBS, LA	1900?	Sudhakar Kar; Vivash Pandey
Keoladeo National Park	Rajasthan	Bharatpur	GC, IS, LC, OD, NH, PH, CE, LE, SE, GE, PrH, GH, PS, OBS, BHI, WSB	1919	Baker, 1935
Vedanthangal	Tamil Nadu	Chegai-Anna	SBP, LC, LE, GH PS, OBS, BHI, WSB	1798	Bates, *loc. cit.*, Baker, 1935; Gee, 1964; Hume and Oates, 1890
Koonthakulam	Tamil Nadu	Tirunelveli	SBP, IS, LC, LE, GH, PS, BHI	1900?	Rhenius, Webb-peploe, 1945; Wilkinson, 1961; Johnson, 1971
Sajnakhali	West Bengal	South 24-Parganas	LC, PH, LE, SE, GE, OBS	1930s	Baker, 1935; Hume and Oates, 1890; Law, 1951
Raiganj	West Bengal	West Dinapur	LC, NH, LE, OBS	1960s	Shahi, 1983

* Names refer to information obtained through personal communications.

TABLE 5
TOP 10 HERONRIES IN INDIA

Name of the heronry	State	Number of species	Number of nests	Source*
Telikunchi Village	Andhra Pradesh	1+	25,000	U.N. Dev; Divya Muddappa, B.C. Choudhury
Keoladeo National Park	Rajasthan	16	10,960	Ali, 1953; Vijayan 1991; Sankhala, 1990
Raiganj	West Bengal	6	10,000+	Shahi, 1983
Sajnakhali	West Bengal	7	10,000+	Baker, 1935; Hume and Oates, 1890; Law, 1951
Bhitarkanika Wildlife Sanctuary	Orissa	13?	10,308+	Sudhakar Kar, Bhivash Pandav, pers. comm.
Ranganathittu Bird Sanctuary	Karnataka	16	8,000+	Personal observations
Kumarakam	Kerala	11	5,000+	Hume amd Oates, 1890; Law, 1951; Kumar Chattopadhyay
Nooranad	Kerala	9	5,000+	K. Rafeek, P.K. Uttaman
Luna Village	Gujarat	8	5,000+	Tiwari (1993)
Gudvi Bird Sanctuary	Karnataka	10	5,000+	Ragunatha *et al.*, 1992; Ragunatha, 1993;

* Names refer to information obtained through personal communications.

in India. Only about 7% of the heronries are traditional nesting sites and some of these heronries have been in existence for well over a century. The Kokkare Bellur Pelicanry, Vedanthangal Bird Sanctuary and Koonthakulam Pelicanry in Tamil Nadu are fine examples of this. Though published records indicate that this pelicanry was in existence in 1864 (Jerdon 1864), enquiries with local people indicate that the colony may well be over 500 years old (pers. obs.).

At these sites birds exhibit a strong site tenacity as observed at Ranganathittu Bird Sanctuary after the devastating 1991 floods (Subramanya *et al.* 1991). Similar re-nesting following disturbance has been observed in Spotbilled Pelicans at Kokkare Bellur Pelicanry (pers. obs.). Such a strong attachment to the nesting site should convince the concerned authorities of the importance of these sites for birds, and efforts should be directed to implement long term conservation plans.

Lost sites: The information on sites where birds once nested is scattered through the literature. The majority of these sites referred to in literature (e.g. Ali 1945, 1955, 1960; Annandale 1921, Baker 1935, Barnes 1886, Bates and Lowther 1952, Betham 1904, Bingham 1876, Burnett 1959, Campbell 1902, Guttikar 1979, Ferguson and Bourdillon 1904, Forbes 1967, Hume and Oates 1890, Law 1926) no longer exist. While no information is available on 147 former sites, 26 nesting sites have disappeared due to various reasons (Table 7). The present status of most of the sites that were known to be active until recently (e.g. Singh and Sodhi 1986, Mahabal 1990) is not known.

TABLE 6
SOME OF THE TRADITIONAL NESTING SITES IN INDIA

Name of the site	State	District	Nesting species	Source*
Telineelapuram	Andhra Pradesh	Srikakulam	SBP, PS	Nagulu and Rao, 1983; M.M.L. Kumar
Neelapattu	Andhra Pradesh	Nellore	SBP, LC, LE, GH, OBS, BHI, WSP	Nagulu, 1983; Nagulu and Rao, 1983
Ethirapattu	Andhra Pradesh	Nellore	LC, LE, PS, WSB	Ramakrishna, 1986, V. Nagulu & Joel Prashanth
Subansiri heroney	Arunachal Pradesh	Upper Subansiri	GC	Baker, 1935
Southern Gulf of Kutch heronries	Gujarat	Jamnagar	LC, OD, NH, PH, WRE, GE, GH, PS, BHI, BI, WSP	Naik *et al.*, 1991; Taej Mundkur
New Port Of Bhavnagar	Gujarat	Bhavnagar	PH, WRE, BHI	Naik and Parasharya, 1987, 1991
Khijadhia	Gujarat	Jamnagar	PH, RE, PS, BHI	Naik *et al.*, 1991; Taej Mundkur; Vinod Pandya
Ghoga Town	Gujarat	Bhavnagar	NH, PH, CE, WRE, LE, SE, GE, PS, BHI, WSB	Naik & Parasharya, 1987; I.R. Gaghvi
Ranganathittu	Karnataka	Mysore	GC, IS, LC, OD, NH, PH, CE, SE, GE, PrH, GH, PS, OBS, BHI, WSB.	Neginhal, 1983, Sharatchandra, 1980; Personal observations
Kokkare Bellur Pelicanry	Karnataka	Mandya	SBP, PH, PS, BI	Neginhal, 1976, Sanjay 1993; Personal observations
Gudvi Bird Sanctuary	Karnataka	Shimoga	IS, LC, OD, NH, PH, LE, SE, GE, PrH, BHI, WSB	Ragunatha, 1993, Ragunatha *et al.* 1992, Personal observations
Bhitarkannika Wild-life Sanctuary	Orissa	Cuttack	LC, OD, NH, SE, PrH, GH, OBS, LA	Sudhakar Kar; Vivash Pandey
Keoladeo National Park	Rajasthan	Bharatpur	GC, IS, LC, OD,NH, PH, CE, LE, SE, GE, PrH, GH, PS, OBS, BHI, WSB	Ali, 1953; Sankhala, 1990
Vedanthangal	Tamil Nadu	Chengai-Anna	SBP, LC, LE, GH, PS, OBS, BHI, WSB	Bates, *loc. cit*,. Baker, 1935; Gee, 1964; Paulraj & Kondas, 1987, Santharam & Menon 1991
Koonthakulam	Tamil Nadu	Tirunelveli	SBP, IS, LC, LE, GH, PS, BHI	Rhenius, Webb-peploe, 1945; Wilkinson, 1961; Johnson, 1971; A. Rajaram; G. Padmanaban, G.S. Sanjay, V. Ragunatha

TABLE 6 (CONTINUED)

Name of the site	State	District	Nesting species	Source*
Chitrangudi Heronry	Tamil Nadu	Ramanathapuram	SBP, GC, IS, LC, OD, PH, CE, LE, GE, GH, PS, OBS, BHI, WSB	Ramachandra Raja; G.S. Sanjay, V. Ragunatha
Vettangudi Patti	Tamil Nadu	Ramanathapuram	SBP, LC, OD, PrH, PS, OBS, BHI, BI, WSB	G.S. Sanjay, V. Ragunatha
Sajnakhali Heronry	West Bengal	South 24-Parganas	LC, PH, LE, SE, GE, OBS	Hume and Oates, 1890; Law, 1951; Kumar Chattopadhyay
Raiganj	West Bengal	West Dinapur	LC, NH, LE, OBS	Shahi, 1983

* Names refer to information obtained through personal communications.

The vast swamps of the Brahmaputra floodplain and its associated beels once supported a large number of heronries (Baker 1935, Hume and Oates 1890), but little information is now available on the existence of these old heronries. The nesting sites that were once found within or close to Barpeta Beel, Dhemaji Beel, Dhemaji Village, around Dibrugarh, Goalpara Swamp, Lakhimpur Swamp, Tinsukia, within the floodplain of Brahmaputra river (Baker 1935) do not seem to exist any more. One of the reasons for this may be the changes in land use pattern in the area (Saikia and Bhattacharjee 1993).

Some of the important sites that have been lost over the century include one of the first nesting colonies of Spotbilled Pelican discovered in India by Campbell (1902); the nesting colony of Great White (Rosy) Pelican (Ali 1960, Shivrajkumar *et al.* 1960); a large heronry consisting of Pelicans, Cormorants, Night Herons, Little Egrets, other herons, ibises and Spoonbills at Tangalle and Mathura (Hume and Oates 1890); a large colony of Little Cormorant, Darter, Pond Herons, egrets, Great Egrets, Openbill Storks, Spoonbills nesting in a village in south Mainpuri district (Hume and Oates 1890). Similarly, a large colony of Painted Storks in Deeg town close to Bharatpur, Rajasthan, which had birds nesting on *Acacia nilotica* growing around the fort and market place in the city, is not known (Chatterjee, pers. comm.). Also, the heronries located on the islands of Chilka Lake (Annandale 1921, Forbes 1967) no longer exist (Sudhakar Kar and K. Mohapatra, pers. comm.).

Protected Heronries: The heronry survey has revealed that only a small proportion of the nesting sites receive protection (Table 8). In addition to those protected by Forest Departments, several traditional nesting sites are protected by the local people; a few nesting sites enjoy protection due to their occurrence in religious places (Table 5). By virtue of their location in government office premises or on private properties, some of the heronries are fortunately inaccessible to people who can harm them. Birds at these sites are least disturbed and the threat to nesting birds is minimised. As a consequence, they continue to nest at these sites regularly.

Threats, disturbances and loss of heronries: Continued survival of heronries is threatened by several factors. Table 9 lists factors that threaten and disturb nesting sites. While some of the factors are common to many heronries, a few are specific to individual heronries. Available information shows that nearly 50 sites are threatened by human induced factors; 21 sites are threatened with natural factors (Table 9). Some of the important factors are discussed below:

Destruction of nesting substrate: Felling of

TABLE 7

SOME OF THE IMPORTANT HERONRIES THAT ONCE EXISTED

Name of the Heronry	State	District	Nesting species	Year of last record	Source*
Snake Island	Andamans and Nicobar		ERE	1897	Osmaston (1900); Davison *loc. cit.*, Baker, 1935
Corbyn's Cove	Andamans and Nicobar		ERE	1897	
Cocos Island	Andamans and Nicobar		ERE	1897	
Oyster Island	Andamans and Nicobar		ERE	1930s	Shopland *loc. cit.*, Baker, 1935
Trinkut Island	Andamans and Nicobar		ERE	1930s	Hopwood *loc. cit.*, Baker, 1935
Ongole (?) Pelicanry	Andhra Pradesh	Prakasam	SBP	1873	Hume, 1881
Pullagoorapalli Pelicanry		Cudappah	SBP	1873	
Buchupalle Pelicanry		Cudappah	SBP, PS	1908	Campbell, 1908
Nellore		Nellore	RE	1961	Kirkpatrick, 1961
Godavari village		? Godhavari	PS	1880s	Burges *loc. cit.*, Hume and Oates, 1890.
Kolleru Pelicanry		West Godavari	SBP, LC	1949	Gee, 1960; Neelakantan, 1949
Tinsukia Railway Station	Assam	Tinsukia	Herons, OD, herons, LE, cormorants, IS	1930s	Baker, 1935
Barpeta Heronries		Barpeta	LC, egrets, OBS, GI	1930s	
North Lakhimpur Heronries		Lakhimpur	LC, IS, OD, egrets, bitterns, OBS	1930s	
South Lakhimpur Heronries		Lakhimpur	LC, egrets, bitterns	1930s	
Mornai Village	Assam	Goalpara	PrH	1930s	Hume and Oates, 1890
Kodasheri River	Kerala	Malappuram?	OD	1900s	Ferguson and Bourdillon, 1904
Bird Island (Chilka)	Orissa	Puri	LC, OD	1858-1867	Forbes, 1967
Charriakuda Island (Chilka)			NH, GH	1921	Annandale, 1921
Kalidai Island (Chilka)			LC, IS	1921	
Sambhur Lake	Rajasthan	Nagur	CE	1870s	Adams (Baker 1935, *loc. cit.*)
Deeg	Rajasthan	Bharatpur	PS	1973	Chatterjee
Lucknow (Oudh)	Uttar Pradesh	Lucknow	OBS	1890s	Hume and Oates, 1890
Lohya Bridge (Ganges Canal)	Uttar Pradesh	Etawah	PrH	1867	Hume and Oates, 1890

Table 7 (Continued)

Name of the Heronry	State	District	Nesting species	Year of last record	Source*
Village Kupser	Uttar Pradesh	Lucknow?	OBS	1861	Irby, 1861
Govardhan (Goburdhum)	Uttar Pradesh	Mathura	PS	1860-1930	Hume, Lindsey Harvey *loc. cit.*, Baker, 1935.
Etawah Graveyard	Uttar Pradesh	Etawah	PH, CE, ME	1856-1866	Hume and Oates, 1890
Umraha Village	Uttar Pradesh	Allahabad	OBS	1890s	Hume and Oates, 1890
Mohar	Uttar Pradesh	Kanpur	BHI, OBS	1890s	Hume and Oates, 1890
Tangalle and Mathura	Uttar Pradesh?	Mathura?	Egrets, Herons, BHI, WSB	1890s	Layard *loc. cit.*, Hume and Oates, 1890
South Mainpuri (Karhal?)	Uttar Pradesh	Mainpuri	LC, OD, PH, egrets, GE, OBS, SPB	1880s	Hume and Oates, 1890
Gorakhpur	Uttar Pradesh	Gorakhpur	GA	1830s	Baker, 1935

* Names refer to information obtained through personal communications.

nesting trees in heronries is a serious factor that contributes to the loss of nesting space. A property dispute over a large *F. benghalensis* tree that used to support about 100 nests led to its felling (Sridhar 1992) and the author's personal observation corroborates the same. Similarly, felling of a *F. religiosa* tree near Mathikere Heronry led to the shifting of the colony to a nearby *F. benghalensis* tree (pers. obs.). The heronries at Ulloor, Vattapara in Trivandrum are lost due to the loss of nest substrate (C. Susanthakumar, pers. comm.).

Destruction of nesting substrate is a major factor contributing to the loss of heronries. As a part of the social forestry program, the foreshore stands of *A. nilotica* were harvested to distribute benefits to the people (Wilson 1986). Heronries at several tanks (Table 10) were destroyed when the *A. nilotica* stand was clear felled (S. Vasuki, pers. comm.). Similarly, at a tank located about 30 km from Coimbatore on the road to Satyamangala, the *A. nilotica* stand which supported a large colony of Little Cormorants and Little Egrets was gradually cut down in 1982 (S.T. Bhaskaran, pers. comm.). The heronry at Rathanpur Jheel close to Ahmedabad was destroyed similarly (Satkopan, pers. comm.). At Kandla Creek, in the Gulf of Kutch, over-exploitation of mangroves has resulted in the disappearance of the heronry that once existed (Ali 1945, Parasharya, pers. comm.). The loss of heronries at several tanks (Abraham 1973) may have been due to the same reason.

The nesting of waterbirds in large colonies is often associated with the offensive smell due to defecation and rotting of fish scraps fallen from the nests. The resulting stench is offensive to people living close by. At Ulloor Heronry in Trivandrum, the nesting tree was cut down by its owner to escape the stench of nesting birds during the monsoon (C. Susanthakumar, pers. comm.). For the same reason, the Vattapara Heronry in Trivandrum was destroyed (C. Susanthakumar, pers. comm.) and the KTC Bus Stop Heronry in Palakkad is threatened.

Developmental activities are often not in favour of nesting birds. A number of heronries have disappeared due to removal of nesting substrate or disturbance consequent to developmental activities.

TABLE 8
STATUS OF PROTECTED HERONRIES IN INDIA

Nature of protection	Number of sites	Per cent sites	Examples
State	42	11.86	Bhitarakanika, Keoladeo National Park, Neelapattu, Sajnakhali, Raiganj, Ranganathittu, Vedanthangal
People	7	1.97	Kokkare Bellur, Koonthakulam, Telineelapuram
Religious sites	9	2.54	Gadhula Village, Gourikoppa Village, Khara Chusna Island, Pirotan Island
Positional effect	8	2.30	Basaveshvarnagar, Ghoga Town, Kadakkal, Indapur, New Port of Bhavnagar, Railway colony Jodhpur, Simpson Estate
Total	66	18.67	

Heronries in different parts of Madras (Krishnan 1979) seem to have disappeared due to development of the city (Santharam, pers. comm.). Similarly, the Salt Lake Colony of Purple Herons in Calcutta (Saha 1969) seems to have disappeared due to developmental activities.

In Assam, a recent search for the nesting colony of egrets which Burnette (1958) photographed in Sibsagar district revealed that over the years, the growth of residential colonies around the site led to the dwindling of the bamboo grove. In 1993, a search for the site yielded only a few culms of bamboo at the site which was once a vast grove that supported a colony of over 200 nests of Cattle and Little Egrets. The birds had abandoned the nesting site nearly 20 years ago owing to clear cutting of bamboo (Deeptimanta Barooah, pers. comm.).

TABLE 9
THREATS AND DISTURBANCES TO HERONRIES

Type of threat or disturbance	No. of sites Affected	No. of sites Lost
Destruction of nesting substrate	3	13
Poaching nestlings/adults	10	2
Human activity	12	—
Predation	11	—
Natural calamities	1	6
Damage to nesting substrates	4	1
Egg gathering	4	—
Lack of suitable foraging areas	—	2
Draining of wetland	—	1
Defoliation of nest tree	—	1
Electrocution	1	—
Rock Bee havoc	1	—

At Moondradaipu, several roadside trees being used by Spotbilled Pelican, Little Cormorants and Painted Storks (Ganguli 1964) were cut down over the years. Subsequently, the nesting site was abandoned by birds in 1989 after a chemical factory was built close by. Following this, the remaining trees were also cut down (Rajaram, pers. comm.).

The Night Heron appears to be very sensitive to disturbance in and around its nesting colony. A large nesting colony of the species at Malleswaram, Bangalore, was abandoned during the early 1970s, following the construction of buildings close by. Such colonies are rarely permanent and in Bangalore the birds have been observed to shift their nesting colonies within a locality. Some of the sites are occupied for a single nesting season.

Damage to nesting substrates: Local fuel and fodder requirement may result in the exploitation of trees used for nesting by birds in heronries. At some of the heronries in the Southern Gulf of Kutch (Bhaider, Nora, Chank, Ghandhiya Kodo and Kalubhar island heronries), fishermen living close to some of the islands frequently lop the nesting substrates for fuel (Naik *et al.* 1991). At Kokkare Bellur, some of the trees utilised by birds are lopped regularly by the local people to provide fodder for their goats. As a consequence, the crowns of these trees get severely deformed, thus reducing the available nest space to birds. This results in the falling out and subsequent loss of nestlings from their nests (Subramanya and Manu 1996). Also, damage to nesting substrates occurs due to developmental activities. At Morvi Town Heronry, the branches of most of the trees used for nesting were pruned in 1987 for the construction of a water tank, leading to the loss of nesting substrate (Taej Mundkur, pers. comm.) and at Gandhiya Baug heronry where bamboo clumps used for nesting by birds were chopped down by the Surat town municipality in 1993 (Sneha Patel, pers. comm.).

Disturbance to nest site: Disturbances to the nesting colony either by human activity or other factors could lead to the abandonding of the nesting site. For example, the Little and Cattle Egrets were nesting on a huge *F. mysorensis* tree found on the island in the middle of the crocodile pond at Jodhpur Zoo. The birds abandoned the site a few years back, after the construction of a bridge linking the island with the mainland, for easy movement of caretakers. As a consequence, semi-feral cats started predating on the nestlings. In addition, the slaughter of animals to feed the carnivores at the zoo started attracting crows and pariah kites which also predated on the contents of unattended nests. All these factors led to the abandoning of the nesting site (Indra Kumar Sharma, pers. comm.). Till 1979, Pond Herons were nesting on shrubs growing on the island in Lalbagh Tank at Bangalore. Clearing of these natural dense shrubs and construction of a land bridge led to the disappearance of the nesting colony (pers. obs.).

Poaching: Poaching of eggs, nestlings and even the nesting birds is a serious threat to the survival of heronries. At Gudvi Bird Sanctuary, poaching of eggs and nestlings was rampant and the size of the nesting colony dwindled till the site received official protection (Raghunatha *et al.* 1992). Nagulu (1993) indicates that poaching was one of the factors that led to abandoning of Kolleru Pelicanry. At Panidihing Heronry, hunting parties regularly raid the nesting colony and steal eggs.

Effect of natural calamities: Natural calamities like floods and cyclones damage heronries to different degrees, and droughts lead to failure of nesting at the site. Floods can be devastating to heronries located amidst rivers or in the floodplains (Neginhal 1980). For example, at Ranganathittu Bird Sanctuary, where birds nest on tree-studded islands midstream of a swift flowing river, flash floods during 1991 raised the water level at the sanctuary by 5 m. The surging waters submerged or washed away ten of the eleven islets, along with the nests built within the five metre level, while the vegetation on some islets was uprooted. A few islets overgrown with screwpine (*Pandanus* sp.) were devegetated. Whatever vegetation withstood the fury of flood was deposited with debris, choking the available nest-space.

Cyclonic storms are often very destructive to heronries. At Ethirapattu Heronry, a huge tamarind tree was uprooted and the side branches of most of the trees were broken (K.Mruthunjaya Rao). Ramakrishna (1990) reports that the side branches of most of the trees were broken in addition to uprooting a huge tamarind tree. When a Neem tree on which Openbill Storks were nesting at Tsunduru Village Heronry was affected by a cyclone in 1990, the birds successfully shifted over to nest on *Polyalthia longifolia* found close by (K. Mruthunjaya Rao, pers. comm.). However, when Jagrugumilli Village Heronry in Prakasham district was hit by a cyclone in 1979, the nesting birds shifted to Patchava Village (K. Mruthunjaya Rao, pers. comm.).

A thunderstorm destroyed the crown of an *Acacia nilotica* tree in Cuddapah city during 1989 and the Pond Herons, Cattle Egrets and Little Egrets which had been nesting on it abandoned the site (Riazuddin, pers. comm.). When the Reef Heron colony at the New Port of Bhavnagar was severely hit during the cyclonic storm in November 1982, a large number of herons were stunned by shock and cold (Naik and Parasharya 1987). The cyclone of 1984 that swept through Neelapattu Sanctuary uprooted a number of nesting trees and resulted in the mortality of a large number of birds (Tehar 1985).

Droughts prevent breeding at traditional colonies in very dry years (e.g. Keoladeo National Park: Ali 1979, Breeden and Breeden 1982, Verghese *et al.* 1982; Vedanthangal: Paulraj 1984, Santharam, pers. comm.; Mainpuri: Hume and Oates 1890). The nesting of birds at Rozi Island and Khijadia Bird Sanctuary is totally dependent on the adequate rainfall received during monsoon (Naik *et al.* 1991). The level of water and the time span during which the water collects in the pond harbouring the nesting tree, is crucial for the nesting of birds. During 1988 and 1989, the monsoon was very good and breeding progressed smoothly. However, due to the failure of monsoon during 1990, the ponds dried up early and the birds did not nest at the site (Naik *et al.* 1991).

Some threats could be peculiar to certain specific sites. At Hebbal in Bangalore, a colony of Night Herons, which had started nesting on *F. religiosa* abandoned the site when the tree shed its leaves during February (pers. obs.). In Kokkare Bellur Pelicanry, a few adult and nestlings of Spotbilled Pelican and Painted Storks die each year after colliding with a 10,000 volt electricity cable that passes through the village where birds nest (pers. obs.). In another situation at the Mathikere Heronry, colonies of Rock Bee *Apis dorsata* share the large trees used by nesting birds. On several occasions, clambering fledglings of birds have bumped into the hives, enraging the bees. In 1993, the villagers of Mathikere observed about 30 very young nestlings of Little Cormorants, Night Heron and Grey Herons being stung to death by enraged bees. The bees stung the bare parts of the nestlings which were unable to fly. Nestlings which were severely stung died after their fall from the canopy.

Conservation of heronries: While a number of heronries are lost (Fig. 4) due to various reasons, only a small percentage of the existing nesting sites are protected. While protecting heronries should be an important conservation issue, the problem is not as simple as protecting a specific heronry. It appears that selection of a specific nesting habitat by these birds is more complex than merely occupying what is usually termed as '*a safe nesting site*'. The choice of a specific nesting site appears to be based mostly on the availability of suitable feeding conditions at a chosen site (Bancroft *et al.* 1988, Carrascal *et al.* 1993, Gibbs *et al.* 1987, Venkataraman and Muthukrishnan 1993) and also the availability of suitable nesting conditions in a specific locality that has the feeding conditions. These two factors appear to be inseparable (Ali and Ripley 1987, Naik *et al.* 1991). The survival of a heronry depends, in addition to the availability of safe nesting sites, on the continued availability of suitable feeding conditions. Thus, at each site chosen for protection, important feeding sites where the nesting birds forage need to be identified and efforts should be directed at protecting them. Observations at Kokkare Bellur Pelicanry have shown that the nesting pelicans and Painted Storks travel as far as 60 km to forage (Sanjay 1993, Subramanya and Manu 1996). The feeding sites comprise of over 150 tanks of varying sizes ranging from less than 10 ha. to more than 100 ha. in area. These tanks, in effect seem to form a feeding habitat complex which supports the nesting population of birds at Bellur.

On the other hand, providing protection to a greater number of heronries against disturbance and habitat destruction, clearing or felling of nest-substrates should be an important strategy to ensure continued survival of heronries. By taking into consideration the types of threats and disturbances affecting heronries (Table 9), several conservation options can be considered. Some of the important options are discussed below:

Bringing more Heronries under State Protection: At present only a few heronries enjoy state protection. Any conservation strategy thus should aim to increase the number of sites coming under state protection. For this, there is an urgent need to identify all promising nesting sites, officially declare them as protected and initiate conservation activities.

Total protection from every form of threat or disturbance: As discussed earlier, one of the major causes for the loss of the nesting sites is the loss of favoured nesting substrate through habitat destruction. Failure to replace the substrate with similar features worsens the situation. Even in protected sites, very little effort is being made to correct the situation. The existing nesting substrate within such sites should be protected from destruction and loss, and concrete steps taken to ensure the adequate future availability of nesting substrate.

Often, the loss of nesting substrate at heronries is tied to local timber, fuel and fodder requirements. An alternate strategy, backed by a strong social forestry programme, should be formulated to meet these local requirements (Subramanya and Manu 1996).

Protection of Roost Sites of large Waterbirds: In many instances, former roost sites have eventually developed into nesting sites. Safety appears to be a key factor promoting the nesting at a former roost site. The occurrence of both roost and nesting sites appears to be governed by two major factors, namely safe sites providing suitable roosting or nesting substrates and the availability of suitable feeding habitat conditions. Prolonged safety from disturbances at a given roost site appears to tempt birds to utilise the same site for nesting. In fact, several heronries have begun as roost sites (Table 10). For example, the banyan tree on which the birds nest at Basaveswarnagar Heronry is located in an isolated corner of an enclosed government office property, where even the employees seldom wander. The site is totally free from disturbance. Birds nesting in heronries seem to have recognized this (pers. obs.).

Table 10
HERONRIES THAT COMMENCED AS ROOST SITES

Name of the site	Roosting species	Nesting species
Hebbal	NH	NH
Basaveswaranagar	LC, NH	LC, NH
Malleswaram	NH	NH
Karanji Tank	OD, GC, PS, WSB	OD, GC, PS,
Soolekere	PS, WSB	PS, WSB
Simpson Estate	LC, IS, OD, LE, CE, RE, ME, GE, GH, BHI, WSB	LC, IS, OD, NH, LE, ME, GE
Madurai City	PH	PH
Pudhugramam	CE	CE
Udayamarthandapuram	GC, IS, LC, OD, NH, PH, CE, LE, GH, PS, OBS, BI, WSB	GC, IS, LC, OD, NH, PH, CE, LE, GH, PS, OBS, BI, WSB
Kumarakam	GC, IS, LC, OD, NH, PH, LE, SE, GE, PrH	GC, IS, LC, OD, NH, PH, LE, SE, GE, PrH
Peppara	GC, LC, IS, OD	LC
VC Farm	LC, PH, LE, CE	PH, LE, CE
Gourikoppa Village	LC	LC

Similarly, the Simpson Estate Heronry in Madras started as a roost site of night herons in the early 1960s. When this roost site received total protection from any form of threat the birds started nesting there. Nearly 11 species making up a population of over 10,000 birds roost at the site and nearly 2,000 nesting birds comprising six species nest at the site today (V.Gurusamy, pers. comm.). Thus, identifying large roost sites of colonial waterbirds and according to them official protection may help nesting in the long run.

Increasing Nesting Substrate Availability: Tree nesting is an important feature among the birds nesting in heronries (Table 2) and in nearly 96 per cent of the sites, trees form the nesting substrates. Loss of trees, as discussed earlier, may be a potential threat resulting in the loss of nesting substrate. As both natural and human influenced factors may affect the availability of trees, it is worthwhile, in addition to protecting existing trees at the site, to ensure future availability of trees for nesting. To achieve this, regular planting of preferred tree saplings is necessary in and around the heronries. These saplings have to be protected from damage till they attain sufficient height. The *A. nilotica* trees planted following the 1984 cyclone at Neelapattu Bird Sanctuary have compensated some of the lost nesting substrate (Nagulu, pers. comm.).

Creation of heronries: Understanding the factors leading to the formation of heronries is useful in deciding on the ways and means of making conditions conducive to nesting at a particular site. Table 11 lists the number of situations where several factors have favoured the starting of a new colony.

Though heronries have to commence at some point of time, the process of selection of nesting site appears to be operating at two levels. To begin with, the area that affords good and suitable feeding conditions is selected and then within this area, a

TABLE 11
FACTORS FAVOURING THE COMMENCEMENT OF HERONRIES

Favouring factors/mode	No. of sites
Foreshore afforestation of tanks	14
Tree trunks in the backwaters of dams	6
Protection of roost sites	10
Suitable conditions in an aviary	3
Afforestation	1
Ideal feeding conditions	2

suitable site that affords sufficient safe nesting substrate is selected (Fasola and Alieri 1992, Fredrick 1989, Gee 1964, Gibbs 1991, Hafner and Fasola 1992, Kushlan 1976). For example, at Kokkare Bellur Pelicanry, studies revealed that birds frequent medium to large tanks located within about 60 km around the nesting site (Sanjay 1993, Subramanya and Manu 1996). Observations indicated that the village was one of the few that had a high tree density. Within the village nesting birds utilize over 100 trees out of nearly 220 trees found within the village (pers. obs.). The nesting birds were safe within the village as they were protected by the sentiments of local people (Neginhal 1993).

While the availability of suitable sites for nesting and feeding are essential to establish heronries, several factors contribute towards meeting the nest site requirements. Though it is not always possible to identify these contributing factors, there are certain situations where it is possible to identify several factors that have favoured the commencement of nesting (Table 12).The influence of some of these factors is discussed below:

Foreshore Afforestation of Tanks: Tamil Nadu Factor: The popular view on the existence of heronries is that these sites are traditional breeding grounds for the birds which have been nesting since a long time. This is true, when one considers sites like Vedanthangal, Koonthakulam, Telineelapuram, Kokkare Bellur, where birds are known to be nesting for a long time (Table 4). However, the commencement of heronries in Ramanathapuram and Tirunelveli districts of Tamil Nadu in mid 1960s (Table 12) indicate that man can help in the creation and establishment of these heronries. In 1960, the Social Forestry Programme, Tamil Nadu Forest Department started foreshore afforestation of a large number of tanks with *A. nilotica* (Wilson 1979). Once the *Acacia* saplings grew to form a dense stand of trees that invariably became partially submerged after monsoon inundation, it provided safe and ideal conditions for the nesting of colonial water birds. The heronries at Vettangudi, Chitrangudi, Kanjeerakulam, Koonthakulam and Vedamugam-Vellode Tank commenced after foreshore afforestation. At Pandoli Tank also, birds started nesting subsequent to the creation of congenial conditions by planting of *A. nilotica* in the foreshore region (R.B. Balar, L.M. Ruol and P.S. Thakker, pers. comm.).

TABLE 12
LIST OF TANKS IN TAMIL NADU WHERE HERONRIES CAME INTO EXISTENCE FOLLOWING FORESHORE AFFORESTATION WITH *Acacia*

District	Name of the tank
Ramanathapuram	Vettangudi
	Chitrangudi
	Kanjeerankulam
	Sakarakotti Konmoi (L)*
	Parai Konmoi (L)
	Cheluvanoor (L)
	Pillayarkulam (L)
	Komboothi (L)
Kanyakumari	Suchindramkulam (L)
	Theroorkulam (L)
	Manakudi Tank (L)
Tirunelveli	Koonthakulam Tank
Periyar	Vellode-Periakulam Tank
	Kangurkulam

* Those marked (L) no longer exist.

Effect of partially submerged nesting substrates: The creation of large irrigation projects has helped the nesting of large waterbirds (Table 5). Their creation in forested river valleys is often associated with the submergence of a considerable extent of forest in the foreshore region, resulting in dead tree trunks standing partially submerged in water. As water acts as an insulating factor around nesting trees against ground predators (Gee 1964), such sites have attracted Darters and Large Cormorants for nesting (Nair and Nair 1973, Nair 1996). In Karnataka, a colony of nearly 500 pairs of Great Cormorants and a few Darters are known to nest on bare tree trunks standing in the backwaters of Kabini Reservoir (Ullas Karanth, pers. comm.).

Partially submerged trees in a large waterbody appear to have been the most preferred nesting substrate for colonial nesting waterbirds. In Gujarat, for example, every reservoir providing such nesting substrates (e.g. Aji-II, Aji-III, Sardhar Reservoir, Mithikhari Reservoir, Nayri Reservoir and Kalaghoga Reservoir), invariably seem to support a heronry. Thus, trees growing either close by or partially submerged, in the shallower regions of the reservoir should be able to attract waterbirds for nesting. (e.g. Nair and Nair 1973, Nair 1996).

Effect of large waterbodies: Creation of large waterbodies seems to have been crucial in the commencement of heronries in the surrounding areas. All the major heronries in inland Kerala are located close to major reservoirs and undoubtedly they appear to have come into existence after the construction of these waterbodies that provide them with crucial feeding habitats. Once the conditions amenable for nesting (feeding and nest-site) are created, one can expect birds to start nesting close by soon.

Attraction of tree covered islands for nesting waterbirds: Dense vegetation covered islands in the midst of flowing rivers or large waterbodies have a considerable attraction to nesting birds. The best examples for such heronries are the Ranganathittu, the islands in the Southern Gulf of Kutch, Jodhpur Zoo and Hemisar Tank Heronry. Construction of tree studded islands (mounds planted with *A. nilotica* amidst the wetland) at Keoladeo National Park, has indeed proven that birds readily colonise them (Sankhala 1990). At Kukkralli Tank Heronry in Mysore Pelicans, Darters, Painted Storks and Spoonbills colonised a tree covered island in the middle of the tank, when drought affected their nesting habitat at Karanji Tank about 5 km away (K. Manu, pers. comm.).

Considering the influence of the above factors in the commencement of heronries, efforts should be made wherever possible to create conditions, as discussed above, suitable for the nesting of large waterbirds.

Establishing nesting colonies in Aviaries: By providing suitable nesting substrates and an assured food supply, it is possible to induce large waterbirds to breed within the confines of large aviaries. In the Bannerghatta National Park Aviary near Bangalore, it has been possible to establish nesting colonies of Spotbilled Pelican, Little Cormorant, White Ibis and Spoonbill (Venkatesh *et al.* 1996). Birds have been observed to breed in similar situations at Vandalur Zoo in Tamil Nadu, Nehru Zoological Park in Hyderabad and Baroda Zoo (Santharam, Aasheesh Pittie and Geeta Padati, pers. comm.)

Involvement of local people: Available information on heronries in India reveals that nearly 80% of the heronries are located within or close to human habitation and in rural settings. To protect these sites, it is important to involve local people living close to nesting sites. Efforts have to be directed at educating and convincing them of the need to protect the nesting sites. Programmes have to be started to actively involve them in conservation activities. In fact, such an exercise has led to the formation of a "*Hejjarle Balaga*", the Village Pelican Conservation Group at Kokkare Bellur Pelicanry in Karnataka (Subramanya and Manu 1996). Efforts should also be made to encourage local non-governmental organisations to identify heronries and work towards protecting them in association with the concerned government departments.

CONCLUSION

Available information shows that much can be done to identify and protect potential heronries in different parts of India as the future of heronries depend much on protecting existing sites and on the quality of protection given to them. Concerted efforts in this direction through regional cooperation of agencies and concerned individuals in different parts of India can help in establishing a network of heronries. Towards this end, there is a need to develop a more detailed inventory of heronries at the district or state level by concerned individuals or by government and non-governmental organisations. This should be followed by bringing more sites under protection.

A comparison of Tables 4, 5 and 6 shows that the age and size of the heronry and the number of species nesting in a colony appears to be related. In other words, the colony size and its species composition grows with time. Thus, it becomes evident that long term protection of nesting sites against every form of threat and disturbance (Table 9) coupled with an increased availability of nesting substrates over the years would go a long way in conserving heronries. It should be kept in mind that man can indeed help in the establishment of heronries by creating conditions facilitating the nesting of waterbirds in select situations.

Further, much can be achieved by creating awareness among the public regarding the importance of these sites and the need to protect them. Especially in instances where the nesting sites are located in private properties, the owners have to be convinced of the importance of such sites and encouraged to protect them through their active participation.

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APPENDIX

DETAILS OF THE HERONRIES REFERRED TO IN THE TEXT

Name of the Heronry	State	District	Nesting species	Source*
Aji-II Reservoir	Gujarat	Rajkot	GC, PrH, WSB	Taej Mundkur
Aji-III	Gujarat	Rajkot	PS	Taej Mundkur
Basaveshvarnagar	Karnataka	Bangalore	LC, NH	Personal observations; Gopi, Prasad
Baroda Zoo Aviary	Gujarat	Baroda	LC, NH, PH, CE, LE	Geetha Padate
Bhaider Island	Gujarat	Jamnagar	OD, WRE, GE, GH	Naik *et al.*, 1991; Taej Mundkur
Chank Island	Gujarat	Jamnagar	WRE, GE, GH	Naik *et al.*, 1991; Taej Mundkur
Chedayankali	Kerala	Palakkad	NH, PH, LE	J. Praveen
Coring Wildlife Sanctuary	Andhra Pradesh	East Godavari	LC, NH, PH, CE, WRE, LE, SE, OBS	Ashok Kumar, V.; Vasudeva Rao and V. Nagulu
Cuddapah	Andhra Pradesh	Cuddapah City	CE, LE,	Riaz Uddin
Dhemaji Village	Assam	Dhemaji	PH, OBS	Baker, 1935
Dibrugarh	Assam	Dibrugarh	GC	Baker, 1935
Gadhula Village	Gujarat	Bhavnagar	WRE	Naik and Parsharya (1987).
Gandhiya Baug Island	Gujarat	Surat	NH, PH, CE, WRE, LE, GH, PS	Sneha Patel & Akshy Joshin

APPENDIX (*Continued*)

Name of the Heronry	State	District	Nesting species	Source*
Gandhiya Kodo Island	Gujarat	Jamnagar	OD, PH, WRE, GE, GH, BHI	Naik *et al.,* 1991; Taej Mundkur
Goalpara Swamp	Assam	Goalpara	PrH	Baker, 1935
Gourikoppa Village	Karnataka	Hassan	LC	K.V. Srinivas
Hebbal Campus	Karnataka	Bangalore	NH	Personal observation
Hemisar Tanl	Gujarat	Kutch	CE	Ali, 1947; Chhaya, 1993
Indapur	Maharashtra	Pune	GH, PS, BHI, BI	Prakash Gole; Anirudh Chaoji; S.N. Naik
Jagrugumilli Village	Andhra Pradesh	Prakasam	PS	K. Mruthunjay Rao
Jodhpur Zoo	Rajasthan	Jodhpur	LE	Indra Kumar Sharma
Kadakkal	Kerala	Trivandrum	PH, LE	K. Rafeek
Kalaghoga Reservoir	Gujarat	Kachchh	PS, BI, WSB	Shanthilal Varu
Kalubhar island	Gujarat	Jamnagar	NH, WRE, BHI	Naik *et a.,* 1991; Taej Mundkur
Kamaleshwar dam	Gujarat	Junagadh	egrets, herons, PS	Anwarkhan Babi
Kanjikode	Kerala	Palakkad	LC, NH, PH, LE	J. Praveen
Khara Chusna Island	Gujarat	Jamnagar	OD, PH, WRE, GE, GH	Naik *et al.,* 1991; Taej Mundkur
Karanji Tank	Karnataka	Mysore	OD, GC, PS, WSB	K. Manu
Khijadia Bird Sanctuary	Gujarat	Jamnagar	PH, RE, PS, BHI	Taej Mundkur
KTC Bus Stop	Kerala	Palakkad	LC, NH, PH, LE	J. Praveen
Kukkralli Tank	Karnataka	Mysore	SBP, OD, PS, WSB	K. Manu, Personal observation
Lankivanidibba	Andhra Pradesh	Krishna	GC, IS, NH, PH, CE, WRE, GE, GH, PS, OBS, WSB	Narendra Prasad; Prasad, 1992
Lakhimpur Swamp	Assam	Lakhimpur	LC, PrH	Baker, 1935
Luna Village	Gujarat	Kuchchh	LC, NH, CE, LE, WSB, GI	Thiwari, 1993; Thiwari
Malleswaram	Kanataka	Bangalore	NH	Personal observation
Manali	Kerala	Palakkad	NH, PH, LE	J. Praveen
Mithikhari Reservoir	Gujarat	Surendranagar	WSB	Taej Mundkur
Morvi Town	Gujarat	Morvi	NH, CE, LE	Taej Mundkur
Nayri Reservoir	Gujarat	Rajkot	WSB	Taej Mundkur
Nora Island	Gujarat	Jamnagar	OD, WRE, GE, GH	Naik *et a.,* 1991; Taej Mundkur
Nooranad	Kerala	Allappuzha	LC, OD, NH, PH, LE, SE, GE	K. Rafeek; P.K. Uttamar
Patchava Village	Andhra Pradesh	Prakasam	PS	K. Mruthunjay Rao
Pandoli Tank	Gujarat	Kheda	LE, SE, OBS. WNS, BI	R.B. Balar, L.M. Raol, P.S. Thakker
Peppara	Kerala	Trivandrum	LC	Deepakumar Kurup
Pirotan Island	Gujarat	Jamnagar	LC, OD, NH, PH,WRE, GE	Naik *et al.,* 1991; Taej Mundkur
Pithalpur Village	Gujarat	Bhavnagar	CE, RE	Naik and Parasharya, 1987
Pudugramam Osaravila	Tamil Nadu	Kanyakumari	CE	C. Susanthakumar
Ratanpur Jheel	Gujarat	Ahmedabad	LC, CE, LE, BI	S. Satkopan
Railway colony Jodhpur	Rajasthan	Jodhpur	CE, LE	Indra Kumar Sharma
Rozi Island	Gujarat	Jamnagar	NH, PS	Naik *et al.,* 1991; Taej Mundkur
Sardhar Reservoir	Gujarat	Rajkot	WSB	Taej Mundkur
Simpson Estate	Tamil Nadu	Madras	LC, IS, OD, LE, CE, RE, ME, GE, GH, BHI, WSB	V. Gurusami
Soolekere	Karnataka	Mandya	SBP, PS	K. Manu; Personal observation
Telikunchi Village	Andhra Pradesh	Srikkakulam	OBS +	U.N. Dev; Divya Muddappa, B.C. Choudhury

APPENDIX (*Continued*)

Name of the Heronry	State	District	Nesting species	Source*
Tsundur Village	Andhra Pradesh	Guntur	LC, CE, LE, OBS	K. Mruthunjay Rao
Udayamarthandapuram	Tamil Nadu		GC, IS, LC, OD, NH, PH, CE, LE, GH, PS, OBS, BI, WSB	K. Sivasubramaniam
Ulloor	Kerala	Trivandrum	LC, PH	C. Susanthakumar
Vattapara	Kerala	Trivandrum	NH, LE	Manoj V. Nair, C. Susanthakumar
Visveswaraiah Canal Farm	Karnataka	Mandya	PH, CE, LE	Pers. observation

* Names refer to information obtained through personal communications.

A REVIEW OF THE BIRDS OF THATTAKAD BIRD SANCTUARY, KERALA

R.Sugathan and Aby P. Varghese[1]

Introduction

In the 19th Century when the British started various types of plantations, the Kannan Devan Hills (now known as Munnar) was one of their main targets for tea plantations in Kerala. To facilitate transport a road was constructed connecting Kannan Devan Hills with Cochin through the western slopes of the Western Ghats. The actual Ghat section of the road started from the right bank of the Periyar river, the second largest river in Kerala. Along the road many travellers' bungalows were constructed, Thattakad being first on the right bank of the river. The British also started the first large scale rubber plantations at 'Palamattam', close to Thattakad. In the early 1930s when Sálim Ali was on his way to the high ranges of the Western Ghats during the Ornithological Survey of Travancore and Cochin, he came through the Old Munnar road. Thattakad being the starting place of the Ghat, Sálim Ali selected it as one of his bird collection centres.

Sálim Ali noted the avifaunal diversity of Thattakad as one among the richest in his survey report. Unfortunately, the area had been exploited for cultivation, first, by the British and later by the locals. After independence some of these unauthorised encroachments were taken over by the Government and vast areas were planted with teak. In the 1980s the Kerala Government proposed to establish a bird sanctuary and asked Dr. Sálim Ali for advice. He immediately suggested that Thattakad should be the first Bird Sanctuary of Kerala. As a result during 1983 an area of 25.16 Sq.Km was declared as a Bird Sanctuary.

An intensive study on the flora and fauna of Thattakad Bird Sanctuary in Kerala was started in March 1994. The project is being funded by the Kerala Forest Department (Wildlife) with a view to study the biodiversity of the area and population size of the various components for the preparation of a scientific management plan. Some of the data furnished below were obtained during the project work.

Study Area

Thattakad Bird Sanctuary (10° 10' N, 76° 40'-76° 45' E) has an area of 25.16 Sq.Km and is bordered by the Periyar and Kuttampuzha rivers on two sides and Kolombathodu and Orulamthanni on the other two sides. It is almost at the foot of the western slopes of the Western Ghats and the altitude ranges from 50-250 m above msl. The highest point in the Western Ghats, the Anamudi Peak (2695 m), is directly uphill of Thattakad. The terrain is undulating and includes two high peaks called Thoppimudi and Njayapillimudi. The river bank has been submerged for about 6 to 10 m by the water body created by an irrigation project, the Bhoothathankettu barrage on the main stream of Periyar river. This has destroyed almost all the luxuriant riverain forest which existed along the banks. About 1/3 of the total Sanctuary area is under monoculture, mainly of teak and mahogany. The remaining forest consists of partly disturbed evergreen, semi-evergreen, moist deciduous Eeta (*Ochlandra travancorica*) forests, and grassland with rock outcrops or even land holdings ranging from 5 0.02 hectares to 4.05 to 6.07 hectares or even more along the fringes of the Sanctuary. However, there are no settlements inside the Sanctuary . Since the declaration of the area as a Sanctuary in 1983, there has been no regular forestry extraction and plantation activities inside the Sanctuary area. As a result, there is fairly thick forest undergrowth everywhere, including in the plantations.

The area was under Malayatoor forest division before the declaration of the Sanctuary but is now under Idukki Wildlife division. The climate is hot and humid. The mean annual temperature varies from 18°C to 37°C. Rainfall is received both during Southwest and Northeast monsoon seasons. However, nearly 75% of the precipitation occurs during the Southwest monsoon, from June to mid September. January and February are generally dry months. The average rainfall is 3000 mm. Strong winds with a speed of over 60 km per hour are common during the monsoon. The controversial Pooyamkutty Hydroelectric project area is very close to Thattakad Bird Sanctuary.

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[1] Sálim Ali Wild Wings Trust, Zoological Research Station, Thattakad Bird Sanctuary, Njayapitty, Kerala.

AVIFAUNA

Thattakad was described as the 'richest bird habitat in peninsular India' by the late Sálim Ali. He reported 163 species of birds from Thattakad alone during the 1930s survey. These were mostly Tropical forest species.

Sálim Ali (1936) in his report JBNHS 37 (4): 835-836 states "The forest which is principally confined to the right bank of the river, consists in patches of both deciduous and tropical evergreen with frequently a mixture of the two. On the right bank of the river also, there is a series of plantations of the Forest Department: Teak, Rubber and *Bombax*. The first is about 6 years old, mostly devoid of undergrowth and poor in bird life. The rubber is about 25 years old, but owing to default of the contractor the weeding has not been done for some years with the result that Lantana, '*Incha*' and a host of other species have overrun the place in impenetrable denseness. This area is the best of the three as regards birds. The *Bombax* plantations (0.25 hectare) is only one year old and little more than a forest clearing so far. When the trees are old enough to flower, this place will become a paradise for the birdwatcher.

"Along the banks of Periyar River, and those of the many small streams that flow into it, are dense clumps of *Eeta* i.e. *Ochlandra travancorica* and they are likewise often lined with 'Ome' trees *Trema orientalis* whose berries are a great attraction to all frugivorous birds.

"No waterbirds were seen except Kingfishers, *Ardeola grayii*, *Anhinga melanogaster* and *Motacilla maderaspatensis* which were usually present in small numbers. The country hereabouts is stiff with wild elephants and bird collection often provided unexpected thrills".

Comparing this with the present status of these areas, we find that most of the natural types have degraded due to constant human interference and cattle grazing. Rubber and *Bombax* plantations are completely replaced with teak plantations. Lantana undergrowth is absent inside the sanctuary. *Bombax* plants are very few in number and there is no natural regeneration of this species inside the sanctuary.

Eeta has almost vanished from the riverside due to formation of the lake. Even though it exists inside the sanctuary in some isolated patches, it is much thinned out due to over-extraction for commercial purposes and from forest fires. 'Ome' (*Trema orientalis*) has also become uncommon due to the regular management practices for the protection of teak plantations.

After the creation of the lake, a considerable increase in water bird population was noticed. Over 30 species of water birds alone have been recorded from Thattakad now. Their population shows an increasing trend now.

The elephant which was common during Sálim Ali's survey was totally absent from the area for a long time, but has now started reappearing during a certain season. During his survey there was no water bird habitat in Thattakad except for the two rivers. Since the 1960s conditions have changed entirely. There is a large water body constituted by the Boothankettu Dam. The depth of the water varies from 1.82 m to 35 m. Water vegetation has established itself over a substantial area providing facilities for water birds to feed and breed, thereby increasing the total population of the avifauna of Thattakad by at least 10 to 15%.

Presently, there are about 270 species of birds reported from Thattakad. About 40% of the total species are migratory, while the others are resident or local migrants. Some are very rare, with only one or two sight records while others are very common. There are also species which were recorded as common by Sálim Ali during 1930's which have become very rare or totally absent. The Great Indian Hornbill, Malabar Pied Hornbill, Laughing Thrush, etc. were recorded as common during the thirties, but have now completely vanished from the study area. There is a fairly good population of birds like Malabar Trogon, Shama, Frogmouth. The peninsular Bay owl which has only been recorded from Parambikulam so far was noticed in Thattakad also. The Black Crested Baza is a breeding resident of this area. Water birds like the Little Cormorant, Large Cormorant, Darter, Shag, Dabchick, Whistling Teal, Bluewinged Teal, Pintail duck, etc. were not recorded by Sálim Ali but have now become very common birds in the water spread area. The Openbill Stork and Purple Heron have made their appearance only two years ago. The Pheasant-tailed and the Bronzewinged Jacanas have started breeding in the water bodies in large numbers. In recent years, there is a seasonal influx of Terns such as the Common Tern, River Tern and the Whiskered Tern, with a population of over a thousand birds during winter migration. The Grey Jungle fowl and the Red Spur fowl population in the sanctuary is fairly good, whereas the quail population is low, even though more than one species are met with.

The large hole nesting birds have either vanished or are very few in numbers, indicating a lack of suitable nesting site. As for their food, it is abundant throughout the year. The frogmouth population was rare, as reported by Sugathan (1981) who conducted a frogmouth population survey during 1979 in the Western Ghats. After 1984, when the area came under the Wildlife Protection Act bamboo and Eeta cutting was completely stopped. The vegetation has now become re-established, enabling frogmouth to increase in numbers. Small sunbirds are one of the altitudinal migrants to the sanctuary in large numbers during November-December every year. Similarly, the Blossomheaded and Roseringed parakeets make their appearance in Thattakad only during August-September in large numbers.

Among the long distance migrants, warblers and flycatchers arrive first. We also get a transit population of flycatchers. A large population of warblers stay back for a long duration. Wagtails like forest wagtails, grey wagtails, etc. are some of the migratory species which stay for a long time.

Kingfishers and bee-eaters nest on the loose sand deposits along the river bed in fairly good numbers. Drongos are common except for the Haircrested Drongo. Owls are many and most of them are breeding residents of the area. Among the swifts and swallows the Eastern Swallow is worth mentioning. They come in thousands during certain days and roost on telegraph and electric wires around the sanctuary. The sanctuary has a small breeding population of the Crested Tree Swift. The recent appearance of Bluewinged teals and Pintail ducks are interesting additions to the fauna. Larger populations of these species have been recorded from Vembanad lake for many years, which lies at a distance of about 35 km as the crow flies from the sanctuary. This year's trend indicates that their population at Thattakad will increase during the coming years.

A detailed study on the population, habitat preference and reasons for disappearances and appearances of certain other species is in progress under the 'Ecology of Thattakad Project'.

BIRD FAUNA OF THATTAKAD

1. **Little Grebe** (*Tachybaptus ruficollis*)

Not very common. Their presence was only recently noticed in the shallow water bodies of the dam catchment in the sanctuary area. Breeding was recorded but the birds totally disappeared during July, August and September when the dam is opened. Not recorded by SA.

2. **Little Cormorant** (*Phalacrocorax niger*)

Common. Recorded only after the construction of the dam. Feeds in the catchment and paddy fields. Breeding not recorded from the sanctuary but seen breeding about a kilometre away from the sanctuary. Not recorded by SA.

3. **Indian Shag** (*Phalacrocorax fuscicollis*)
Only two records within the last 3 years. They are not regular visitors. Seen in the catchment areas. Not recorded by SA.

4. **Cormorant** (*Phalacrocorax carbo*)
Only two records within the last 3 years. They are not regular visitors. Seen in the catchment areas. Not recorded by SA.

5. **Darter** or **Snake Bird** (*Anhinga rufa*)
Not uncommon in the water bodies. There is a constant increase in their population, but breeding not recorded around the sanctuary. During certain months their population fluctuates, going down to a minimum in July, August, September and thereafter slowly increasing to reach a maximum in February and March. Not recorded by SA.

6. **Grey Heron** (*Ardea cinerea*)
Very few and irregular, only 3 or 4 records from the sanctuary area. Breeding not recorded, affects the water edges with marshy vegetation. Not recorded by SA.

7. **Purple Heron** (*Ardea purpurea*)
Not uncommon. Few individuals are regularly recorded from the low water areas of the catchment. This year an increase in population was noticed. Not seen breeding inside the sanctuary.

8. **Little Green Heron** (*Ardeola striatus*)
Very rare visitor to the sanctuary water body. Seen only for a few days. Not recorded by SA.

9. **Pond Heron** or **Paddy Bird** (*Ardeola grayii*)
Common all along the water edges and even along small streams inside the sanctuary. Breeding colony recorded not from within the sanctuary but about a kilometre away. Shares the nesting trees with little cormorants. Nests mainly on Tamarind trees.

10. **Cattle Egret** (*Bubulcus ibis*)
Commonly seen but totally absent during the breeding season. Seen deep into the forest, in the company of cattle and sometimes even with wild elephants.

11. **Large Egret** (*Ardea alba*)
Not uncommon during the season along the shallow water bodies. Totally absent from June to September. No breeding records from and around the sanctuary area.

12. **Smaller Egret** (*Egretta intermedia*)
Rarely recorded in the company of other egrets in the water body. Seen only from October to February.

13. **Little Egret** (*Egretta garzetta*)
Somewhat common during the season October to February every year in the company of other egrets in the shallow water areas. Totally absent from June to September. Not recorded by SA. No breeding record within the sanctuary limits.

14. **Night Heron** (*Nycticorax nycticorax*)
Not very common. A few birds exist within the sanctuary limit around pandanus plants near the water body. Even though breeding was not recorded from the sanctuary area, subadult birds are seen every year with the adults. Not recorded by SA.

15. **Chestnut Bittern** (*Ixobrychus cinnamomeus*)
Even though their population is fairly good outside the sanctuary, they are rare within. Mostly seen among vegetation along the water's edge. No records of breeding of this species from the sanctuary, though they are seen throughout the year.

16. **Malay** or **Tiger Bittern**
(*Gorsachius melanolophus*)
Rare. Only two sight records from the sanctuary area. Can be a seasonal migrant. Not recorded by SA.

17. **Yellow Bittern** (*Ixobrychus sinensis*)
Very few, only 3 records from the Lake's bank.

18. **Black Bittern** (*Ixobrychus flavicollis*)
Their population is larger than that of the other bitterns. Seen along the banks of the Lake and even along stream banks of the sanctuary.

19. **Openbill Stork** (*Anastomus oscitans*)
Only recorded during the last two years from Thattakad, as many as 61 birds were observed along the low water areas, feeding on *Pila*. It was noticed that they collect *Pila* from water, keep a few of them at one place and feed on the contents. Clumps of empty shells were also seen along the water's edge. They were not seen breeding within the sanctuary limits but subadult birds have been recorded along with the adult. The number fluctuates during certain months. Not recorded by SA.

20. **Whitenecked Stork** (*Ciconia episcopus*)
Rare, only 3 records from the sanctuary. Not breeding. Not recorded by SA.

21. **Pintail Duck** (*Anas acuta*)
Migratory. Not recorded from this area till two years ago. Last year about 60+ were seen flying over and later about 20+ seen in one of the water bodies of the sanctuary. Over 3000 birds were seen in the catchment of Edamalayar dam which was constructed only a few years back and is only about 15 km away from the sanctuary area. The species was not recorded by SA.

22. **Spotbill Duck** (*Anas poecilorhyncha*)
Seasonal visitor along with the pintails. Only 5 to 10 birds were seen feeding in the inland water bodies of the catchment in the sanctuary area. No breeding records. Not recorded by SA.

23. **Garganey** (*Anas querquedula*)
Migratory. Only about 5 birds were recorded from the water body in the sanctuary for two days in January in the company of other ducks and teals. Not recorded by SA.

24. **Blackwinged Kite** (*Elanus caeruleus vociferus*)
Not uncommon, in the open patches of the sanctuary. About 8 have been recorded constantly, of which two pairs were seen breeding within the sanctuary limit on trees along the edges of forest clearings.

25. **Black Crested Baza** (*Aviceda leuphotes*)
Not uncommon, in the evergreen patches of the sanctuary. About six have been recorded constantly, of which two pairs were seen breeding within the sanctuary limit on tall trees. They move in flocks of 5 to 6 during the non-breeding season.

26. **Honey Buzzard** (*Pernis ptilorhyncus*)
Only two records from the forest area inside the sanctuary. Not regular. No records of breeding within the sanctuary limit.

27. **Pariah Kite** (*Milvus migrans govinda*)
Not common, but seen along the river course especially when the water is low in the reservoir. Even though they are not recorded breeding inside the sanctuary the nests are seen on trees at the nearest town which is about 10 km from the sanctuary.

28. **Brahminy Kite** (*Haliastur indus*)
Not uncommon inside the sanctuary as well as along the catchment and habitation along the boundary of the sanctuary. Breeding recorded along the sanctuary's edge.

29. **Shikra** (*Accipiter badius butleri*)
Resident, not uncommon in the light wooded areas of the sanctuary. Breeding recorded inside the sanctuary.

30. **Crested Goshawk** (*Accipiter trivirgatus*)
Uncommon. Resident in the deciduous and evergreen forest areas, but not seen breeding within the sanctuary.

31. **Sparrow-Hawk** (*Accipiter nisus*)
Winter visitor, not common. Seen in the well wooded forest areas of the sanctuary.

32. **Besra Sparrow-Hawk** (*Accipiter virgatus*)

Rare in the moist deciduous and evergreen forest areas. Resident but nesting not confirmed from the sanctuary.

33. **Crested Hawk-Eagle** (*Spizaetus cirrhatus*)

Rare, resident. One pair nested in the sanctuary in 1984 in semi-evergreen forest.

34. **Bonelli's Eagle** (*Hieraaetus fasciatus*)

Rare. Only 3 records from the sanctuary. Though resident, breeding not yet recorded within the sanctuary. They are confined to well wooded areas.

35. **Booted Hawk-Eagle** (*Hieraaetus pennatus*)

Rare. Only one record, perhaps a winter visitor to the semi-evergreen forest area of the sanctuary.

36. **Black Eagle** (*Ictinaetus malayensis*)

Casual visitor to the open rocky hills of the sanctuary. Always seen in gliding flight. There are few records during recent years from the sanctuary area.

37. **Grey Headed Fishing Eagle**
(*Ichthyophaga ichthyaetus*)

Common. Resident and breeding in the sanctuary. Roosts on dead tree stumps very close to the water body.

38. **Scavenger Vulture** (*Neophron percnopterus*)

Very rare, seen only three or four times in the sanctuary, possibly a straggler. Always seen soaring alone high up in the sky.

39. **Pale-Harrier** (*Circus macrourus*)

Rare. Winter visitor to the grass-covered hillsides and open water body.

40. **Montagu's Harrier** (*Circus pygargus*)

Not rare during winter. A few birds are seen flying over open water bodies of the sanctuary and sometimes seen perched on isolated poles on the water's edge. Migratory. Not recorded by SA.

41. **Pied Harrier**
(*Circus melanoleucos*)

Rare. Only two or three records. Possibly a passage migrant. Seen around the lake habitat. Winter visitor. Not recorded by SA.

42. **Marsh Harrier** (*Circus aeruginosus*)

Winter visitor. Only two records, seen in an open grassland encircled by water.

43. **Short-Toed Eagle** (*Circaetus gallicus*)

Rare. Resident eagle, recorded from the cultivated area close to the sanctuary. Breeding not recorded. Not met with by SA.

44. **Crested Serpent Eagle** (*Spilornis cheela*)

Resident. Perhaps the commonest among the eagles of Thattakad. Couple of nests with young and eggs were recorded both from the natural forest as well as from the Teak plantations. Affects forest and plantation areas.

45. **Osprey** (*Pandion haliaetus*)

Winter visitor. Rare. Recorded during migratory season from the open water bodies of the sanctuary. Not recorded by SA.

46. **Peregrine Falcon** (*Falco peregrinus*)

Rare. Winter visitor. Only 5 or 6 records from the open water body and grassland surrounded by water in the sanctuary area.

47. **Redheaded Merlin** (*Falco chicquera*)

Only one record of this species from Thattakad near the top of a hill encircled by forest, possibly a straggler. Not recorded by SA.

48. **Kestrel** (*Falco tinnunculus*)

Winter visitor. Not uncommon in the lowland forest, plantation and grassland with scrub.

49. **Indian Kestrel**
(*Falco tinnunculus objurgatus*)

Possibly a local migrant seen during certain months gliding along the hill tops.

50. **Travancore Red Spurfowl** (*Galloperdix spadicea stewarti*)

Common, resident. Affects scrub jungle and deep forest, often feeds along with domestic hens of nearby habitations.

51. **Grey Jungle Fowl** (*Gallus sonneratii*)

Resident, common. Forest as well as plantations and the forested habitat near human settlements close to the sanctuary. Breeds in large numbers.

52. **Banded Crake** (*Rallina eurizonoides*)

Rare, status unknown. Recorded during migratory season from the water's edge close to forest areas. Breeding not yet recorded.

53. **Ruddy Crake** (*Porzana fusca*)

Rare. Only two records. Seen in inland marshy area. Breeding not recorded.

54. **Baillon's Crake** (*Porzana pusilla*)

Rare, winter visitor. Only two records from the sanctuary among the *Ochlandra* undergrowth near the water body.

55. **Whitebreasted Waterhen** (*Amaurornis phoenicurus*)

Common, resident. Breeding in the scrub jungle and lightly wooded forest, even close to habitations and near the stream bed.

56. **Kora** or **Water Cock** (*Gallicrex cinerea*)

Rare, seasonal migrant to the marshes of the sanctuary. Breeding not recorded.

57. **Pheasant-tailed Jacana** (*Hydrophasianus chirurgus*)

A rare resident. Though it had been seen earlier outside the sanctuary, this year it bred inside the sanctuary. Seen on water vegetation in the water bodies of the sanctuary. Not recorded by SA.

58. **Bronzewinged Jacana** (*Metopidius indicus*)

More common than the previous species. Resident along the floating vegetation in the water body. Breeds in fairly good numbers. The abundance has been noticed only during the last two years. Not recorded by SA.

59. **Painted Snipe** (*Rostratula benghalensis*)

Rare. Local migrant, only a few records from the sanctuary. Affects reedy marshes along inland water body.

60. **Blackwinged Stilt** (*Himantopus himantopus*)

Fairly common, winter visitor. Large influx in flocks along shallow water bodies are noticed during May and June. This species has not been recorded till recent years and was not seen by SA.

61. **Small Indian Pratincole** (*Glareola lactea*)

Uncommon. Status unknown. It was recorded as common when a large sand bank was available along the river course before the construction of the dam. It was also recorded breeding during that time.

62. **Redwattled Lapwing** (*Vanellus indicus*)

Common, resident, affects the grassland area along the shores of the water body. Breeds in fairly good numbers. Feeds along the water's edge and grassland in the sanctuary.

63. **Little Ringed Plover** (*Charadrius dubius*)

Rare, seasonal, subspecies not yet confirmed. Seen in the marshy places of the sanctuary only during winter migration. Not recorded by SA.

64. **Green Sandpiper** (*Tringa ochropus*)

Winter visitor in small numbers along the water's edge where there is marshy vegetation. Not recorded by SA.

65. **Wood Sandpiper** (*Tringa glareola*)

Fairly common during winter migration in marshy areas and water's edge. Not recorded by SA.

66. **Common Sandpiper** (*Tringa hypoleucos*)

Winter visitor, fairly common as isolated birds feeding along the water's edge and stream bed and roosting on mudflats or projecting rocks near water.

67. **River Tern** (*Sterna aurantia*)

Common during winter migration. All of them disappear by April end or May and start reappearing by October-November. Some larger unidentified terns were also noticed in flight. These birds are a recent introduction to this area and their numbers are increasing year after year. Not recorded by SA.

68. **Greyfronted Green Pigeon** (*Treron pompadora*)

A resident, common breeding bird of the evergreen and moist deciduous forests of the sanctuary. Large influx was noticed during the fruiting of *Bridelia squamosa, Aporosa lindleyana, Ficus* sp. etc. Local movements were also noticed according to the availability of certain fruits.

69. **Orangebreasted Green Pigeon**
(*Treron bicincta*)

Resident, subject to local movements related to fruiting seasons. Common during February-March in the evergreen and moist-deciduous forest areas of the sanctuary.

70. **Imperial Green Pigeon** (*Ducula aenea*)

Resident, not uncommon and subject to local movements in the disturbed, evergreen and moist-deciduous forest areas.

71. **Blue Rock Pigeon** (*Columba livia*)

Resident, common outside the sanctuary. In flight occasionally they cross over the sanctuary. Other than this they do not belong in the sanctuary.

72. **Nilgiri Wood Pigeon**
(*Columba elphinstonii*)

Not uncommon, resident with local movements between the moist evergreen forest and plantations with secondary forest.

73. **Spotted Dove** (*Streptopelia chinensis*)

Not very common inside the sanctuary but 25 to 30 recorded feeding in the cultivated area after harvest along the fringes of the sanctuary. Resident, a few nests seen along the degraded forest close to the boundary line.

74. **Emerald Dove** (*Chalcophaps indica*)

Outside the sanctuary in the teak plantation towards Punnekkad they are seen in fairly good numbers. Breeding inside the sanctuary is not recorded. Resident in the evergreen and deciduous forest areas.

75. **Large Indian Parakeet**
(*Psittacula eupatria*)

A very rare, resident. Only two sightings inside the sanctuary. This bird was one of the very common species in the 1930s. Large scale capture during the 1950s and before, can be the reason for their reduction in numbers.

76. **Roseringed Parakeet** (*Psittacula krameri*)

A common resident almost all over the sanctuary. They go out of the sanctuary for feeding. Many nests were recorded within the sanctuary limits.

77. **Blossomheaded Parakeet**
(*Psittacula cyanocephala*)

Resident, common. Large influx was noticed during harvesting seasons August-September, January-February. Breeding has been recorded.

78. **Bluewinged Parakeet** (*Psittacula columboides*)

Common during August-September, not recorded breeding inside the sanctuary. They could be altitudinal migrants from the higher elevations of the Western Ghats where they are recorded breeding.

79. **Malabar Lorikeet** (*Loriculus vernalis*)

A common, resident breeding inside the sanctuary. Moves locally according to the flowering of silk cotton, *Erythrina*, etc. and fruiting of fig species. Affects evergreen moist-deciduous and secondary undergrowth of the Teak plantations.

80. **Redwinged Crested Cuckoo**
(*Clamator coromandus*)

Rare; migratory. Only a few records from the teak plantations of the sanctuary.

81. **Pied Crested Cuckoo** (*Clamator jacobinus*)

Not common. Does not seem to be a resident of the sanctuary. Only seen during December to March in the deciduous forest and teak plantations.

82. **Common Hawk-Cuckoo** (*Cuculus varius*)

Common, resident with population fluctuation during June-September season.

83. **Indian Cuckoo** (*Cuculus micropterus*)

Common during certain seasons. Breeding not yet recorded inside the sanctuary.

84. **Cuckoo** (*Cuculus canorus*)

Rare, migratory, seen in the forest as well as in plantations inside the sanctuary.

85. **Indian Banded Bay Cuckoo** (*Cacomantis sonneratii*)

Rare, status unknown in the forest areas as well as plantations of the sanctuary.

86. **Indian Plaintive Cuckoo** (*Cacomantis passerinus*)

Not common, status uncertain. Seen in the open forest areas. During the migratory season.

87. **Rufousbellied Plaintive Cuckoo** (*Cacomantis merulinus*)

Not common. Status uncertain. Not recorded breeding. Seen in the plantations and deciduous forests.

88. **Drongo Cuckoo** (*Surniculus lugubris*)

Only two records from the teak plantations of the Sanctuary.

89. **Koel** (*Eudynamys scolopacea*)

Common, resident, breeding mostly outside the sanctuary area. Population fluctuation noticed indicating local movements.

90. **Crow Pheasant** (*Centropus sinensis*)

A common, resident, breeding inside the sanctuary .

91. **Lesser Coucal** (*Centropus toulou*)

Rare, only 4 records from the scrub jungle and tall grass inside the sanctuary.

92. **Barn Owl** (*Tyto alba*)

Rare inside the sanctuary but recorded breeding atop a church building close to the sanctuary.

93. **Grass Owl** (*Tyto capensis*)

Not common. Resident in forest area near open grassland in the sanctuary. Breeding not yet recorded inside the sanctuary.

94. **Peninsular Bay Owl** (*Phodilus badius ripleyi*)

Very rare. Only a single specimen collected from the boundary of the sanctuary, while it was being attacked by crows. This is the second specimen so far collected from Kerala. Not recorded by SA.

95. **Collared Scops Owl** (*Otus bakkamoena*)

A fairly common, breeding resident inside the sanctuary, both in the forest as well as in the plantations.

96. **Eagle Owl** or **Great Horned Owl** (*Bubo bubo*)

Rare. Status unknown. Only one record from the sanctuary area.

97. **Forest Eagle Owl** (*Bubo nipalensis*)

Not uncommon, breeding resident in the evergreen and moist deciduous forest.

98. **Brown Fish Owl** (*Bubo zeylonensis*)

Common resident breeding inside the sanctuary. Affects well wooded forest area close to open water bodies.

99. **Jungle Owlet** (*Glaucidium radiatum*)

A common, breeding resident. Affects moist deciduous forest, secondary jungle, plantations, etc.

100. **Brown Hawk-Owl** (*Ninox scutulata hirsuta*)
Rare, resident in the forested area near water bodies.

101. **Short-eared Owl** (*Asio flammeus*)
Rare, winter visitor, affects open grassy patches of the catchment. Not recorded by SA.

102. **Ceylon Frogmouth**
(*Batrachostomus moniliger*)
Rare. Breeding resident in the evergreen and *Ochlandra* areas of the sanctuary.

103. **Greateared Nightjar**
(*Eurostopodus macrotis*)
Rare, resident, breeding on the grass covered hilltop, close to the evergreen and moist deciduous forest.

104. **Indian Jungle Nightjar** (*Caprimulgus indicus*)
Rare. A single specimen was collected from Thattakad in December 1984. Possibly a winter visitor.

105. **Common Indian Nightjar**
(*Caprimulgus asiaticus*)
Rare, migratory, only one recorded during 1984 bird survey.

106. **Franklin's Nightjar** (*Caprimulgus affinis*)
Perhaps the commonest among nightjars in the sanctuary. Resident on hilltops with deciduous forest and grassland.

107. **Longtailed Nightjar**
(*Caprimulgus macrurus*)
Rare, resident, on the hillsides with moist deciduous forest.

108. **Large Brownthroated Spinetail Swift**
(*Chaetura gigantea*)
A rare resident. Affects rocky grass covered hilltop with very steep rocky cliffs.

109. **Whiterumped Spinetail Swift**
(*Chaetura sylvatica*)
A rare resident, of the open grassy hilltop.

110. **Alpine Swift** (*Apus melba*)
Rare. Status unknown, open hilltops with steep rocky cliffs.

111. **House Swift** (*Apus affinis*)
Status unknown, seen in small numbers with other swifts during November-March .

112. **Palm Swift** (*Cypsiurus parvus*)
A common swift, not resident inside the sanctuary but frequently seen in the open areas outside.

113. **Crested Tree Swift**
(*Hemiprocne longipennis*)
Not uncommon. Resident, breeds inside the sanctuary area. Frequents openings close to well wooded forest areas. Favourite roosts are isolated dead trees in between the open areas in the wooded forest. As many as 16 to 20 birds were seen roosting on such trees. They also nest on dead tree branches.

114. **Malabar Trogon** (*Harpactes fasciatus*)
A not uncommon, breeding resident. Affects evergreen and moist deciduous forest and also plantations like Mahogany. Sometimes seen in groups of about five birds.

115. **Lesser Pied Kingfisher**
(*Ceryle rudis travancoreensis*)
Not uncommon along the lake side. Breeding resident. Regular nesting area is the loose sand banks along the river. Feeds in the water body and along the main stream.

116. **Common Kingfisher**
(*Alcedo atthis taprobana*)
A common, resident seen almost all over the water spread areas along the water's edge. Breeding inside the sanctuary area.

117. **Threetoed Kingfisher** (*Ceyx erithacus erithacus*)

Rare, only two records from the streams along forests of the sanctuary. Resident but breeding not recorded.

118. **Storkbilled Kingfisher** (*Pelargopsis capensis capensis*)

Somewhat common along the river bed and waterspread areas of the sanctuary. Breeding also recorded. They are resident and become vocal during the breeding season.

119. **Whitebreasted Kingfisher** (*Halcyon smyrnensis fuscus*)

Commonest among the kingfishers. Breeding resident. Seen all over the sanctuary.

120. **Chestnutheaded Bee-eater** (*Merops leschenaulti*)

Common during October-December indicating local movements. They are resident, breeding within the area in small numbers. Prefer open area around the lake.

121. **Bluetailed Bee-eater** (*Merops philippinus*)

A rare migrant but sometimes large numbers are met with. Stays only for a few days. Possibly a passage migrant. Prefers open areas.

122. **Green Bee-eater** (*Merops orientalis*)

A common, resident. Large roosts of over 100 to 200 birds are seen in the sanctuary during December-January.

123. **Bluebearded Bee-eater** (*Nyctyornis athertoni*)

Only a few birds are seen in the well wooded drier areas of the sanctuary. Resident, but nest not yet discovered inside the sanctuary.

124. **Indian Roller** (*Coracias benghalensis*)

Not very common inside the sanctuary. Resident with local movement. Outside the sanctuary limit, in the catchment, seen nesting regularly on some of the dead coconut trees. Very vocal during the breeding season.

125. **Broadbilled Roller** (*Eurystomus orientalis*)

Not uncommon, breeding resident. Affects the evergreen and semi-evergreen forest and also the well wooded areas on the fringes of the water bodies.

126. **Hoopoe** (*Upupa epops*)

Rare, resident. Breeding not recorded inside the sanctuary but fairly common in the teak plantations and rocky openings near Punnekad, 2 km from the sanctuary.

127. **Common Grey Hornbill** (*Tockus birostris*)

Rare. Status uncertain. Very few records from the sanctuary.

128. **Malabar Grey Hornbill** (*Tockus griseus*)

Common, resident, breeding in the sanctuary. Prefers evergreen and moist deciduous forests. It also comes to habitations to feed on some cultivated fruits and seeds.

129. **Malabar Pied Hornbill** (*Anthracoceros coronatus*)

A very rare resident. SA recorded this species as somewhat common in the 1930s. Only a few sightings from the sanctuary in 1984.

130. **Great Pied Hornbill** (*Buceros bicornis*)

This species is also very rare in the sanctuary now. A breeding resident. Outside the sanctuary area it is somewhat common. In the 1930s SA recorded it as one of the common species of Hornbill in Thattakad.

131. **Large Green Barbet** (*Megalaima zeylanica inornata*)

Rare. No recent record but during 1984 one bird was seen inside the sanctuary area. Status unknown.

132. **Small Green Barbet** (*Megalaima viridis*)

A common, breeding resident. Affects evergreen, moist-deciduous forests, plantations and also gardens and groves close to the sanctuary.

133. **Crimsonthroated Barbet** (*Megalaima rubricapilla*)

Common, but seems to be rare due to its shy nature. Not evident except for its calls. A breeding resident. As many as 30 birds were seen on a small ficus tree during the fruiting season.

134. **Wryneck** (*Jynx torquilla*)

Rare. Status unknown. Seen in the scrub jungle and open deciduous forest.

135. **Speckled Piculet** (*Picumnus innominatus*)

Resident, and not uncommon. Breeding in the semi-evergreen and mixed bamboo forests. Dead teak trees are one of their favourite places for both feeding and nesting.

136. **Rufous Woodpecker** (*Micropternus brachyurus*)

Rare, resident, affects teak plantations, deciduous forest and bamboo areas.

137. **Little Scalybellied Green Woodpecker** (*Picus myrmecophoneus*)

Rare, resident, breeding in the semi-evergreen and moist deciduous forest.

138. **Lesser Goldenbacked Woodpecker** (*Dinopium benghalense*)

Resident, not uncommon and breeding. Affects semi-evergreen, deciduous forests, teak and other plantations.

139. **Indian Goldenbacked Threetoed Woodpecker** (*Dinopium javanense malabaricum*)

Common all over the sanctuary including plantations. A breeding resident.

140. **Great Black Woodpecker** (*Dryocopus javensis*)

A rare breeding resident. Affects the evergreen and moist deciduous forests.

141. **Pigmy Woodpecker** (*Picoides nanus*)

Not uncommon. Resident. Affects secondary forest in the plantations and bamboo forest areas.

142. **Heartspotted Woodpecker** (*Hemicircus canente*)

Not uncommon, breeding resident. Affects secondary evergreen and moist deciduous forest and plantations with bamboo.

143. **Large Goldenbacked Woodpecker** (*Chrysocolaptes lucidus*)

Common. Resident all along the forest areas including teak plantations and cultivation around the sanctuary.

144. **Indian Pitta** (*Pitta brachyura*)

Common, and migratory. Abundant during the migratory (November-March) season all along the forest, plantation and scrub jungle near habitations. A large influx was noticed during certain days in November and March, lasting only for a few days.

145. **Bush Lark** (*Mirafra assamica*)

Resident but not common. Affects scrub jungle and short grasslands.

146. **Rufoustailed Finch-Lark** (*Ammomanes phoenicurus*)

Rare. One specimen was collected from a grassy area of Thattakad sanctuary during 1984 . Not recorded by SA.

147. **Malabar Crested Lark** (*Galerida malabarica*)

Not uncommon, resident, seen on the stone covered grassy hilltops and also around cultivation.

148. **Eastern Skylark** (*Alauda gulgula*)

Rare, resident near cultivated open areas close to the sanctuary. Nesting recorded from the cultivated area outside the sanctuary.

149. **Crag Martin** (*Hirundo rupestris*)

Possibly a winter visitor. Rare, seen in the company of swifts and swallows in the open rocky hilltop area of the sanctuary.

150. **Dusky Crag Martin** (*Hirundo concolor*)

Rare and possibly a resident, but breeding not recorded within the sanctuary. Seen around Thattakad ferry in the company of swallows.

151. **Eastern Swallow** (*Hirundo rustica gutturalis*)

Common during migratory season. Winter visitor. Large congregations during certain days of November-December were observed in the open areas of the sanctuary and for a short duration. Large numbers roost on electric and telephone wires outside the sanctuary, and were also seen feeding in the paddy fields after harvest and at the time of ploughing.

152. **House Swallow** (*Hirundo tahiti*)

Not uncommon, resident but breeding not recorded. Prefers grassy hill slopes and steep rocky area close to settlements.

153. **Wiretailed Swallow** (*Hirundo smithii*)

Rare, possibly a winter visitor. Seen on the hilltop close to steep ridges of rocky outcrops.

154. **Indian Cliff Swallow** (*Hirundo fluvicola*)

Very rare, only one or two sight records from the open hilltops of the sanctuary.

155. **Redrumped Swallow** (*Hirundo daurica*)

Somewhat common during November-February possibly a migrant. Breeding not recorded.

156. **House Martin** (*Delichon urbica*)

Occasional visitor to this area. A rare migrant. Open hilltop area.

157. **Grey Shrike** (*Lanius excubitor*)

Very rare. Only two records within the sanctuary, both from the scrub jungle around open water body. No breeding records. Possibly a local migrant.

158. **Baybacked Shrike** (*Lanius vittatus*)

Rare. Status uncertain. No breeding records. Prefers open scrub and deciduous forest.

159. **Rufousbacked Shrike** (*Lanius schach*)

Only a single record from the sanctuary recently. Possibly a winter visitor. Seen in teak plantation.

160. **Brown Shrike** (*Lanius cristatus*)

Very rare, winter visitor to the sanctuary. Prefers open scrub and dry teak plantations towards the end of the winter season.

161. **Golden Oriole** (*Oriolus oriolus*)

Winter visitor. Common during migratory season. Affects evergreen, semi-evergreen forests, plantations and trees in urban areas close to the sanctuary.

162. **Blacknaped Oriole** (*Oriolus chinensis*)

Winter visitor. Rare. Scattered population occurs in the evergreen, deciduous forests and teak plantations.

163. **Blackheaded Oriole** (*Oriolus xanthornus*)

Common, resident, breeding in almost all the habitats inside the sanctuary. Found in evergreen, deciduous forests, plantations and in urban areas inside and outside the sanctuary.

164. **Black Drongo** (*Dicrurus adsimilis*)

Common, resident. Breeding inside the sanctuary. Affects deciduous forest and plantations.

165. **Grey** or **Ashy Drongo** (*Dicrurus leucophaeus*)

Winter visitor, common during the migratory season. Affects deciduous, semi-evergreen forest and plantations.

166. **Whitebellied Drongo** (*Dicrurus caerulescens*)

Rare, resident. Breeding not yet confirmed inside the sanctuary. Affects deciduous forest and teak plantations.

167. **Bronzed Drongo** (*Dicrurus aeneus*)

Not uncommon. Resident in evergreen and deciduous forest. Rare in teak plantations.

168. **Haircrested Drongo** (*Dicrurus hottentottus*)

Resident, subject to local movements mainly in connection with the flowering of silk cotton and *Erythrina.* Rare inside the sanctuary but common in Edamalayar area. Found in evergreen, deciduous forests.

169. **Greater Racket-Tailed Drongo** (*Dicrurus paradiseus*)

Common, resident, breeding in the sanctuary. Affects evergreen, deciduous forests and plantations.

170. **Ashy Swallow-Shrike** (*Artamus fuscus*)

Common, resident. Seen all along the edges of forest openings and water spread areas. Favourite nesting sites are dead coconut palms in the inundated areas around the sanctuary.

171. **Greyheaded Myna** (*Sturnus malabaricus malabaricus*)

Local migrant. Common during migratory season. Seen in the semievergreen, deciduous forests and teak plantations. Large flocks of over 100 birds seen flying around and suddenly settling on certain tree species such as teak and silk cotton during February-March.

172. **Blyth's Myna** (*Sturnus malabaricus blythi*)

Local migrant. Common during migration. Affects all types of forest, moves in flocks.

173. **Rosy Pastor** (*Sturnus roseus*)

Winter visitor. Not regular. In certain years, a few flocks pass through the sanctuary. Not seen staying in the sanctuary.

174. **Common Myna** (*Acridotheres tristis*)

Common, resident along the fringes of the sanctuary and also in some of the openings inside the sanctuary in association with cattle and some wild animals, like elephants.

175. **Jungle Myna** (*Acridotheres fuscus*)

Resident. Common in the open grasslands and inside light wooded forest areas. Sometimes seen feeding in mixed flocks with common myna in the company of grazing cattle and wild animals.

176. **Grackle** or **Hill Myna** (*Gracula religiosa*)

Common, resident, breeding in large numbers in the sanctuary. Prefers evergreen, semi-evergreen, deciduous forests and also teak plantations.

177. **Common Tree Pie** (*Dendrocitta vagabunda*)

Common, breeding resident in the deciduous, semi-evergreen forests and plantations.

178. **Southern** or **Whitebellied Tree Pie** (*Dendrocitta leucogastra*)

Common in the forest. Resident and breeds in the sanctuary. Inhabits evergreen, moist deciduous forests and teak plantations.

179. **House Crow** (*Corvus splendens*)

Common resident. Though seen inside the forest it prefers areas around habitation.

180. **Jungle Crow** (*Corvus macrorhynchos*)

Common, resident in small numbers in company with the house crow. Met with even in deep jungle.

181. **Pied Flycatcher Shrike** (*Hemipus picatus*)

Common resident. Breeds in the deciduous forest and teak plantations.

182. **Malabar Wood Shrike** (*Tephrodornis pondicerianus*)

Not uncommon, resident. Affects secondary jungle and teak plantations.

183. **Large Cuckoo-Shrike** (*Coracina novaehollandiae*)

Common, resident in the mixed forest and teak plantations.

184. **Blackheaded Cuckoo-Shrike** (*Coracina melanoptera*)

Common, resident. Affects mixed forest, secondary jungle and teak plantations.

185. **Scarlet Minivet** (*Pericrocotus flammeus*)

Resident but not very common. Met with in flocks of 10 to 15 in the evergreen and deciduous forest and plantations.

186. **Small Minivet** (*Pericrocotus cinnamomeus*)

Rare. Resident in the deciduous forest and teak plantations.

187. **Common Iora** (*Aegithina tiphia*)

Common resident, breeds in the sanctuary. Almost all habitats but only few seen in the evergreen forest.

188. **Goldfronted Chloropsis** (*Chloropsis aurifrons*)

Resident, not uncommon. Inhabits almost all types of forest.

189. **Jerdon's** or **Goldmantled Chloropsis** (*Chloropsis cochinchinensis*)

Rare. Resident in the dry areas of the sanctuary.

190. **Fairy Bluebird** (*Irena puella*)

Common. Status unknown, nesting not recorded from the sanctuary. Start appearing during the onset of the SW monsoon and disappear during October, when the regular migration starts. Becomes vocal during April-June.

191. **Greyheaded Bulbul** (*Pycnonotus priocephalus*)

Resident. Not uncommon in the evergreen forest areas of the sanctuary. Breeds in the sanctuary.

192. **Rubythroated Bulbul** (*Pycnonotus melanicterus gularis*)

Common, resident, frequents evergreen deciduous and secondary jungle. Breeds in the sanctuary .

193. **Redwhiskered Bulbul** (*Pycnonotus jocosus*)

Common, resident in scrub jungle and also near habitations.

194. **Redvented Bulbul** (*Pycnonotus cafer*)

Common, resident in the light deciduous forest and scrub jungle near habitations.

195. **Yellowbrowed Bulbul** (*Hypsipetes indicus*)

Not uncommon, resident of evergreen and deciduous forest areas. It is also seen in the secondary jungle in old teak plantations.

196. **Spotted Babbler** (*Pelorneum ruficeps*)

Resident, not common. Breeding recorded. Frequents evergreen and deciduous forest, *eeta* and bamboo areas.

197. **Blackheaded Babbler** (*Rhopocichla atriceps*)

Resident, common in the evergreen forest, *eeta* and bamboo areas and even in the thick undergrowth of old teak plantations.

198. **Rufous Babbler** (*Turdoides subrufus*)

Not uncommon, breeding resident. Affects dense scrub with tall grass, along stream sides in the evergreen to deciduous forest with *eeta* and bamboo brakes.

199. **Jungle Babbler** (*Turdoides striatus*)

A common breeding resident, of the disturbed and deciduous jungle and teak plantations. Also in scrub jungle near habitation.

200. **Wynaad Laughing Thrush** (*Garrulax delesserti delesserti*)

Rare, resident, very rarely seen nowadays. Sálim Ali's survey described it as one of the commonest birds in Thattakad. Inhabits humid rain forest with dense undergrowth.

201. **Quaker Babbler** (*Alcippe poioicephala*)

Resident, rare. Frequents mixed bamboo and *eeta* jungle, cane brakes in evergreen forest.

202. **Brown Flycatcher** (*Muscicapa latirostris*)

Rare. A small population is seen in the sanctuary throughout the year. During the migratory season an increase in population was noticed, indicating an influx of migrants. Seen in the evergreen, deciduous forests and plantations with low density of vegetation.

203. **Brownbreasted Flycatcher** (*Muscicapa muttui*)

Rare. Winter visitor to the evergreen and semi-evergreen forests and bamboo areas.

204. **Rufoustailed Flycatcher** (*Muscicapa ruficauda*)

Rare winter visitor to the evergreen and teak plantations with secondary vegetation.

205. **Redbreasted Flycatcher** (*Muscicapa parva*)

Rare winter visitor to the plantations and deciduous forest.

206. **Whitebellied Blue Flycatcher** (*Muscicapa pallipes*)

Rare winter visitor (?) to the evergreen forests.

207. **Bluethroated Flycatcher** (*Muscicapa rubeculoides*)

Rare winter visitor to the secondary forest, bamboo jungle and plantations.

208. **Tickell's Blue Flycatcher** (*Muscicapa tickelliae*)

Not uncommon, winter visitor. Frequents evergreen and deciduous forest with open undergrowth, bamboo jungle and plantations.

209. **Verditer Flycatcher** (*Muscicapa thalassina*)

Not uncommon, winter visitor in the forest clearings, secondary jungle and to plantations.

210. **Nilgiri Flycatcher** (*Muscicapa albicaudata*)

Not common, but resident in the evergreen, semi-evergreen forest, and teak plantations with thick undergrowth.

211. **Whitebrowed Fantail Flycatcher** (*Rhipidura aureola*)

Rare, resident, occurs in deciduous forests and plantations close to habitation.

212. **Paradise Flycatcher** (*Terpsiphone paradisi leucogaster*)

Common. Mostly migratory. All over the forest and plantation areas, even close to the water's edge and habitations.

213. **Blacknaped Flycatcher** (*Hypothymis azurea styani*)

Rare, winter visitor to the secondary jungle, bamboo forest and teak plantations.

214. **Streaked Fantail Warbler** (*Cisticola juncidis*)

Rare resident, prefers reed beds, tall grass and cultivated areas along the fringes of the sanctuary.

215. **Franklin's Wren Warbler** (*Prinia hodgsonii*)

Resident, subject to local movements, frequents scrub jungle with coarse grass and secondary vegetation along the water's edge.

216. **Jungle Wren-Warbler** (*Prinia sylvatica*)

Rare, resident in isolated grassy patches in the lower areas of the sanctuary.

217. **Tailor Bird** (*Orthotomus sutorius*)

Common, resident in scrub jungle and disturbed forest, and near habitation. etc. Breeding recorded.

218. **Pallas's Grasshopper Warbler** (*Locustella certhiola*)

Rare winter visitor to scrub jungle and grasslands around water bodies.

219. **Grasshopper Warbler** (*Locustella naevia*)

Rare winter visitor. Affects edge vegetation of reservoirs and grassy hill slopes.

220. **Broadtailed Grass Warbler** (*Schoenicola platyura*)

Resident but not common. Affects grass and scrub covered hillsides.

221. **Thickbilled Warbler** (*Acrocephalus aedon*)

Winter visitor, not uncommon during migration. Frequents undergrowth in light forest, tall grasses and among vegetation along the water's edge.

222. **Indian Great Reed Warbler** (*Acrocephalus stentoreus*)

Rare winter visitor to the reeds and scrub of damp areas.

223. **Blyth's Reed Warbler** (*Acrocephalus dumetorum*)

Winter visitor. Common during migration. Affects bushes, secondary forest, undergrowth of plantations and deciduous forest, bamboo and *eeta* clumps, etc.

224. **Paddyfield Warbler** (*Acrocephalus agricola*)

Rare, winter visitor to the grasslands close to water body reed-beds, bamboo forest close to water bodies.

225. **Booted Warbler** (*Hippolais caligata*)

Rare, winter visitor found in the deciduous scrub jungle in the sanctuary.

226. **Lesser Whitethroat** (*Sylvia curruca*)

Winter visitor, very few, but considerably large influx was noticed as passage migrants during certain days in the month of November in the scrub jungle and undergrowth of plantations and deciduous forest.

227. **Tytler's Leaf Warbler** (*Phylloscopus tytleri*)

Very rare, only one record from the undergrowth of teak plantations in the sanctuary.

228. **Tickell's Leaf Warbler** (*Phylloscopus affinis*)

Winter visitor. Very rare. Only two records from scrub jungle close to the reservoir from Thattakad.

229. **Largebilled Leaf Warbler** (*Phylloscopus magnirostris*)

Not uncommon winter visitor. Seen in the evergreen, deciduous forest and plantations.

230. **Greenish Leaf Warbler** (*Phylloscopus trochiloides*)

Fairly common winter visitor. Seen in the evergreen, deciduous forest and plantations.

231. **Blue Chat** (*Erithacus brunneus*)

Winter visitor. Fairly common during migration. Seen in the *eeta* and bamboo forests. Evergreen forest and thick undergrowth of teak plantations.

232. **Magpie-Robin** (*Copsychus saularis*)

Common resident in the neighbourhood of human habitation, secondary jungle, and plantations.

233. **Shama** (*Copsychus malabaricus*)

Resident, not uncommon. Affects deciduous forest, bamboo patches and dense secondary undergrowth.

234. **Indian Robin** (*Saxicoloides fulicata*)

Rare, resident. Seen on the rocky hilltops and isolated stony patches in the plantations along the fringes of the sanctuary.

235. **Blueheaded Rock Thrush** (*Monticola cinclorhynchus*)

Winter visitor, not very common. Affects secondary evergreen jungle and the thick undergrowth in teak forest.

236. **Malabar Whistling Thrush** (*Myiophonus horsfieldii*)

Resident, not uncommon, seen along the forest streams with *eeta* undergrowth and in the evergreen forest areas. Becomes vocal only during June-Septemeber when it is easy to locate the bird.

237. **Pied Ground Thrush** (*Zoothera wardii*)

Rare, passage migrants, seen only for a short duration. Affects somewhat open forest ground with shrubs in the evergreen and plantation areas.

238. **Orangeheaded Groundthrush** (*Zoothera citrina citrina*)

Migratory, fairly common during season in the thick undergrowth of the wet forest floor and bamboo areas.

239. **Whitethroated Ground Thrush** (*Zoothera citrina cyanotus*)

Resident, rare. Though breeding inside the sanctuary area is not recorded, birds are seen almost throughout the year. They prefer secondary dense jungle, bamboo, *eeta* and shady ravines.

240. **Grey Tit** (*Parus major*)

Resident, not uncommon. Breeds in the sanctuary. Found in deciduous forest and teak plantations.

241. **Velvetfronted Nuthatch** (*Sitta frontalis*)

Resident, not common. Seen in the evergreen, deciduous forests and teak plantations.

242. **Kerala Rock Pipit** (*Anthus similis travancoriensis*)

Rare, resident in the grass covered rocky openings on the hill tops.

243. **Paddyfield Pipit** (*Anthus novaeseelandiae*)

Rare, resident, seen on the bare rock covered hill slopes.

244. **Forest Wagtail** (*Motacilla indica*)

Fairly common during migration. During November-February every year large influx was noticed. A few scattered populations exist throughout the migratory season on the floor of the forest areas.

245. **Greyheaded Yellow Wagtail** (*Motacilla flava thunbergi*)

Common during migratory season. Winter visitor to the sanctuary including water's edge and undergrowth of plantations.

246. **Blueheaded Yellow Wagtail** (*Motacilla flava beema*)

Rare, migrant; seen in the company of Greyheaded Wagtail.

247. **Yellowbacked Wagtail** (*Motacilla flava lutea*)

Rare, winter visitor, possibly a passage migrant.

248. **Western Yellowheaded Wagtail** (*Motacilla citreola*)

Rare, winter visitor, possibly a passage migrant.

249. **Grey Wagtail** (*Motacilla cinerea*)

Common, winter visitor seen along stream beds and rocky river banks.

250. **White Wagtail** (*Motacilla alba*)

Rare, winter visitor along the water courses of reservoir among scrub undergrowth.

251. **Large Pied Wagtail** (*Motacilla maderaspatensis*)

Common, resident. Breeds in holes in buildings. Lives close to human habitation and also water bodies.

252. **Tickell's Flowerpecker** (*Dicaeum erythrorhynchos*)

Common resident seen in the deciduous forest and teak plantations with *Loranthus* sp.

253. **Purplerumped Sunbird** (*Nectarinia zeylonica*)

Common resident in light secondary jungle and plantations. Also near habitations.

254. **Small Sunbird** (*Nectarinia minima*)

Common. Local migrant. Large influx was noticed during winter (Dec.-Jan.). Confirmed records of altitudinal migration from Munnar to lower country available during winter.

255. **Loten's Sunbird** (*Nectarinia lotenia*)

Rare, breeding resident. Prefers well wooded open country and moist deciduous forest areas.

256. **Purple Sunbird** (*Nectarinia asiatica*)

Common, resident in the deciduous forest, plantations and cultivated gardens.

257. **Yellowbacked Sunbird** (*Aethopyga siparaja*)

Very rare. Possibly resident. Only 2 records during 1976 and 1984.

258. **Little Spiderhunter** (*Arachnothera longirostris*)

Common, resident in the evergreen, moist deciduous forest and teak plantations with secondary undergrowth.

259. **House Sparrow** (*Passer domesticus*)

Rare, resident in the nearby inhabited areas where it is common. Rarely met with in the open patches along the fringes of the forest.

260. **Yellowthroated Sparrow** (*Petronia xanthocollis*)

Resident, not uncommon in the deciduous forest and teak plantations often seen on the electric and telegraph lines along the roadside close to the sanctuary.

261. **Travancore Baya** (*Ploceus philippinus*)

Rare, only seen crossing over the sanctuary. Resident outside the sanctuary. Very common in the paddy fields and coconut gardens around the sanctuary about 10 to 15 years back. There is a steep decline in their population during recent years around this area.

262. **Streaked Weaver Bird** (*Ploceus manyar*)

Except for 2 seen (RS) during 1976, there is no record of this species from the sanctuary.

263. **Red Munia** (*Estrilda amandava*)

Rare, resident. Frequents reeds and tall grass near water body.

264. **Green Munia** (*Estrilda formosa*)

Rare, status unknown. Not breeding in the sanctuary.

265. **Whitethroated Munia** (*Lonchura malabarica*)

Rare, seems to be non resident, seen in flocks of 10 to 15 during December in the grassland, bamboo forest and light secondary jungle.

266. **White Backed Munia** (*Lonchura striata*)

Common, resident. Flocks of 10 to 30 feed in the open grassland. Affects bamboo jungle, light secondary and deciduous forest where they are breeding.

267. **Rufousbellied Munia** (*Lonchura kelaarti*)

Rare, resident in the scrub jungle and bamboo clumps in and around waterbodies. Feeds in the grassland and cultivated fields near settlements.

268. **Spotted Munia** (*Lonchura punctulata*)

Not uncommon, resident. Affects open forest patches with secondary jungle and grassland. Also comes to cultivation for feeding.

269. **Blackheaded Munia** (*Lonchura malacca*)

Perhaps the commonest resident munia. Seen among vegetation all along the water's edge, even nesting on plants in water. Feeds in grassy patches.

270. **Common Rosefinch** (*Carpodacus erythrinus*)

Rare, winter visitor to wooded country as well as scrub and bamboo forest in the sanctuary. Possibly a passage migrant to high altitudes where they are common.

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BREEDING SEASON AND CONSERVATION OF THE TERNS *STERNA FUSCATA* AND *ANOUS STOLIDUS* IN THE LAKSHADWEEP

D.N. Mathew[1], George Mathew[1] and Tara Gandhi[2]

(*With two text-figures*)

The Lakshadweep or Laccadive island (Lat. 6°-12° 30' N, Long. 71°-74° E) consist of twenty six uninhabited and ten inhabited islands, situated at distances of 155-248 km from Cochin on the Western coast of India. The climate is warm and humid and the annual rainfall recorded in an inhabited island was 1500-1650 mm. The islands rise only 1-2 m above sea level and have no rivers. The human population rose from 13,861 in 1901 to 51,681 in 1990. Coconut trees and fishes are important natural resources, while low grade phosphates derived from bird droppings and calcium carbonate sands are important mineral resources of the islands.

Pitti, a 1.2 hectare barren and uninhabited island has supported breeding colonies of thousands of the terns, *Anous stolidus* (Noddy) and *Sterna fuscata* (Sooty). Several observers have visited Pitti and recorded the conditions of nesting terns and made crude estimates of the number of birds present between 1963 and 1995. We visited Pitti more frequently between 1990 and 1995. The exact timings and length of the breeding season of terns could not be determined so far due to the high winds which make landing and staying for a long time on Pitti extremely risky.

The following is a consolidated summary of the recent observations of the tern breeding colony of Pitti. In this paper we are examining the scanty data available so far on the terns of Pitti, to see if it is possible to suggest any pattern in the timing of breeding of the birds on this island.

The breeding season: The islanders who collect tern eggs regularly from Pitti, believe that collection of eggs will not endanger the survival of terns in Pitti as the birds either breed throughout the year or have a sufficiently long breeding season. They believe that collection of eggs early in the breeding season will be compensated by laying again later. However, we do not share that view for the following reasons:

1. Pitti is only 1.2 hectare in area and it cannot hold much more than 1 lakh breeding birds and no observer has estimated the tern population to be over 20-30 thousand birds. If the colony had been expanding there should have been more than a lakh of terns in Pitti.

2. Much larger breeding colonies of sooty terns holding millions of birds have disappeared during the last 50 years from the Western parts of tropical Indian Ocean (Feare 1984).

3. No ornithologist has visited Pitti between June and August. It is impossible to say at present whether the terns continue to breed during these monsoon months or have a break and resume breeding in September.

How do the terns survive in Pitti? With the limitation due to lack of information on the activities of terns from June to August, we can point out the following as the options available to the terns nesting in Pitti:

1. By a normal long breeding season starting from April and ending in December during which sufficiently large numbers of chicks survive.

2. By acyclic breeding in which breeding takes place at a cycle of 9-10 months instead of 12 months.

Which of the options do the terns use? 1. If the terns were breeding during the months of fair weather only, it is doubtful if even fifty percent of the eggs would be productive as egg collection is

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TABLE 1

Year	Observers	Estimates of the total (of all terns) in Pitti	Remarks
1963 October	Mathew and Ambedkar (Unpublished)	20,000	Nesting activity in progress collections strictly prohibited.
1978 February	Mathew (unpublished)	12,000	Nesting of sooty terns in progress both adults and eggs collected by human beings.
1986 April	Deepakumar	No estimates	Sooty terns, Noddy, Large Crested terns nesting.
1988 December	Deepakumar	13,000 to 15,000	Found no chicks but about 400 eggs.
1990 May	Mathew, Rajan	4,000	Egg laying in progress of both Sooty and Noddy. Eggs and birds collected by humans.
1991 February	Tara Gandhi, Mathew, Santharam, G. Mathew	2,000	No nesting activity.
1991 April	Mathew, Santharam, G. Mathew, Rajan	8,000	Both Sooty and Noddy terns nesting. No chicks. All the eggs laid collected by humans.
1993 October	Mathew, G. Mathew, Raheem	6,638	Noddy tern fewer with chicks. Sooty and Large Crested terns incubating and with newly hatched young.
1994 May	Mathew, Raheem	3,000	Noddy tern nesting.
1995 September	Raheem, Mathew	6,700	No eggs. 600-700 young of Sooty terns.

easier at this time. Pitti can be approached safely from three inhabited islands up to the middle of May. Our experience has been that the eggs laid till early May, chicks and even some adult birds are collected. Chances of survival are perhaps better from September to December as human predation will be less severe, weather conditions being unpredictable during this period. During severe storms, eggs and chicks are said to be swept away and destroyed. Crabs and Turn-stones also take a heavy toll of the eggs during the breeding season.

2. The climatic conditions in recent years are so unpredictable that it will be harmful to the terns to have fixed and normal annual breeding cycle. If the breeding season was exactly cyclic, one would always find the same breeding chronology year after year, which is not the case. Again Lakshadweep seas have many areas of upwelling (Nair *et al.* 1986) and there does not appear to be any shortage of prey animals for birds. So availability of food may not be an important factor influencing nesting success in Pitti, so much so that there is no particular advantage in breeding annually.

3. Non-annual cycles: Ashmole (1971) in Perrins (1983) pointed out how a small number of seabirds like the bridled terns on Cousin Island and

MONTH / YEAR	J	F	M	A	M	J	J	A	S	O	N	D
1963										●		
1978		●										
1986				●								
1988												●
1990					●							
1991		○		●								
1993										●		
1994					●							
1995									●			

● nesting activity
○ no nesting activity

Fig. 1. The nesting cycle of terns breeding on Pitti.

sooty terns on Ascension Island have non-annual breeding cycles. The bridled tern breeds every eight months and the sooty tern every 9.6 months.

In the statement above, the months on which terns were noted nesting in Pitti during the last four decades are presented, with some details of nesting (Table 1).

From Table 1 it is certain that the terns of Pitti do not breed during the same months, year after year. It seems highly probable that they have a non annual cycle of 9-10 months like the Sooty Terns of Ascension Island. Such a cycle will have the added advantage of breeding four times every three years (Fig. 1)

Status of birds in Pitti

Is the composition of birds of Pitti changing frequently due to emigration and immigration? In 1963, Mathew and Ambedkar ringed over thirty juvenile terns in Pitti. None of these were ever reported. So far we have never received reports of recaptured terns ringed in other oceanic islands in the Lakshadweep. In Seychelles a sooty tern ringed as a chick in New Zealand in 1961 was recovered (Feare, pers. comm.) in 1995. This points to the migratory habits and longevity of these terns.

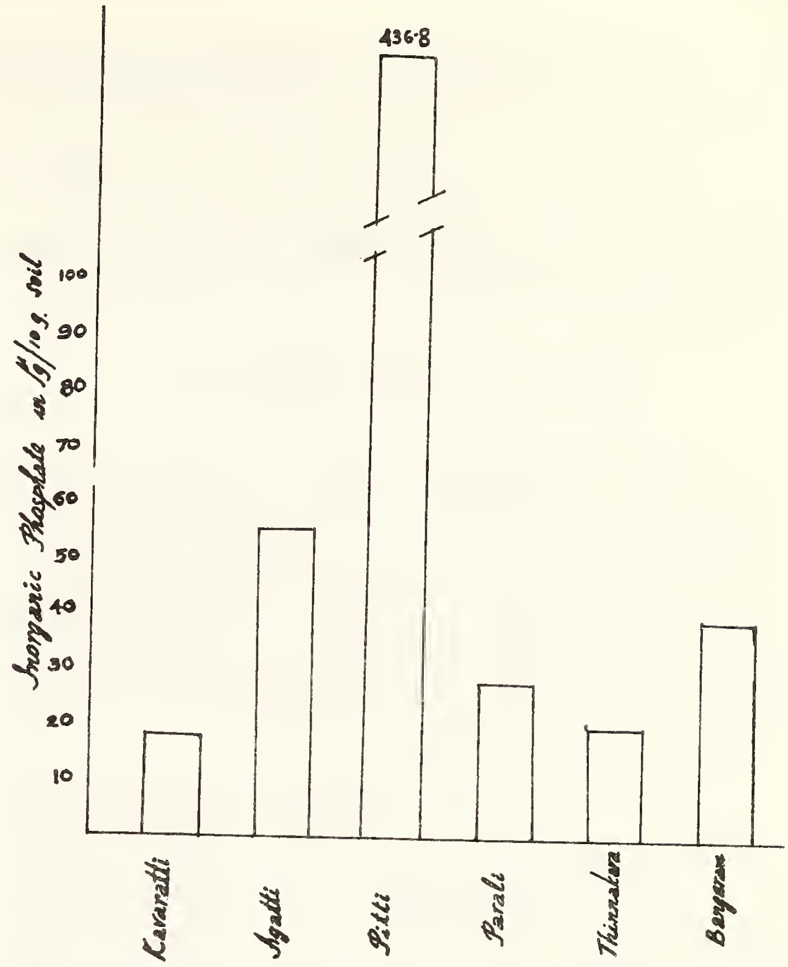

Fig. 2. Phosphate content of the soil samples collected from different islands.

Are the persons receiving ringed birds in Lakshadweep not revealing the fact due to fear of punishment? This is also possible as the birds are protected by law. It appears highly likely that the terns of Pitti are more mobile than they appear to be now. This has to be determined by ringing birds in Pitti.

Large Crested Terns breeding on the Pitti: In October 1993, D.N. Mathew and G. Mathew found Large Crested terns incubating eggs between rows of Sooty terns. There was no conflict between these two species but sooty terns and noddy terns always nested in distant areas of Pitti.

Brownwinged Terns: The last record of the brownwinged tern nesting in the Lakshadweep Islands was that of Mathew and Ambedkar (1963) at Cherbaniani. Deepakumar who visited the island in 1986 could not find any brownwinged terns.

The role of terns in the island's economy: The tern colony is valuable to the island's ecology and economy in several ways. The birds feed on the small fish spratelloides which is a favourite food of

Tuna fish and the islanders use flocks of terns feeding in the sea as tuna indicators. Feeding on the fish of the ocean and resting on the islands, the terns play a significant role in nutrient cycling, particularly of phosphorus. Soil samples taken from Pitti were rich in phosphates (Fig. 2).

Summary and Recommendations

1. The length and pattern of breeding season of the terns of Pitti still remain unresolved due to the absence of data during the monsoon months.

2. Information collected so far suggests that the Sooty and Noddy terns breed acyclically on Pitti. The Large Crested tern appears to have a more restricted breeding season.

3. From the crude estimates obtained so far it would appear that the population of the terns of Pitti is not showing any appreciable increase in number, inspite of a long breeding season and declaration of Pitti as a sanctuary.

4. At present there is no information from recovery of marked birds to determine the exact status of the terns found on Pitti. It is suggested that a scheme for ringing birds should be started here.

5. Analysis of the soil samples collected from Pitti and other islands showed a very high value of Phosphate content in the samples from Pitti, revealing the role of terns in nutrient recycling.

6. It is very clear that the tern populations of Lakshadweep plays very vital roles in certain spheres of the ecology and economy of the islands. The Government of Lakshadweep has very wisely declared Pitti as a sanctuary and the collection of terns and their products as illegal.

Yet these laws are very difficult to enforce because of the distance of Pitti from inhabited islands. Added efforts must be made to educate the public through all possible media about the need to give complete protection to the breeding colony at Pitti.

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KYASANUR FOREST DISEASE AND THE BIRD MIGRATION STUDY OF THE BOMBAY NATURAL HISTORY SOCIETY

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In the mid 1950s a new disease was reported in the Kyasanur Forest area of Karnataka State, causing high fever and other symptoms among infected persons. In addition, there were reports of dead monkeys found in the forest. These reports set off an alarm reaction from Public Health authorities.

Monkey deaths in the forests of Africa often preface an outbreak of Yellow Fever. There is no Yellow fever in India but we have all the ingredients necessary for it to flourish. The insect vector, the *Aedes aegypti* mosquito is common; climatic and environmental conditions similar to those in Central Africa are found in many parts of India. Yet we have not had any outbreaks. There is a possibility that we have some factor or factors which inhibit the spread of Yellow Fever Virus, but until such factor or factors are recognized it behoves the Indian health authorities to be always on guard.

Accordingly, the Virus Research Centre in Pune, specialized in insect or arthropod borne virus diseases, was asked to investigate the outbreak.

It was soon established that this was not Yellow Fever, but was caused by a hitherto unknown virus which was named Kyasanur Forest Disease Virus. This KFD virus was found to be closely allied to the virus of Russian Spring Summer Encephalitis (RSSE) which occurs in Siberia and regions around Lake Baikal. Every year thousands of birds from arctic and subarctic regions migrate south to winter in warmer areas where food and shelter are available. Many of those from Siberian regions come and winter in India. Could it be that migrating birds carried the virus from Siberia to India?

To resolve this question the World Health Organisation planned a study of migratory birds coming to India, and of their insect parasites, if any, which could transmit the disease to new hosts.

Sálim Ali, the leading ornithologist of India, who had been interested in the migration of birds, was requested to undertake the study for the WHO, and the Virus Research Centre was entrusted with the study of insect parasites and viruses, if any, carried by them. A five year study was planned and a grant for this was made to the BNHS with Sálim Ali as chief investigator. A series of trapping stations were set up at various places favoured by migrating birds. The birds were trapped in mist nets, carefully removed, identified and measured. Insects attached to them were removed by combing. These were appropriately labelled and carried to the Virus Research Centre for further study and detection of viruses. The birds were then tagged with a lightweight aluminium ring bearing an identifying number (entered against the bird's details in the record), and was then released.

The BNHS exercised its usual care and economy for these studies so that when the five year period ended there was enough money left to continue for a further three years. The WHO meanwhile had lost interest. Since no virus infected birds or insects were found among the thousands trapped every year it was concluded that if at all such transfer of infection occurred, it must be a rare and aberrant phenomenon, not justifying the effort of continuous monitoring. The Virus Research Centre also, having identified the new virus and established that it was transmitted by a tick usually found in the forest undergrowth, which in turn infected animals in the forest and sometimes humans, lost interest in migrating birds. The rest of the study was therefore confined to the study of bird migration.

RESULTS

Migration: About 1,50,000 birds of various species were trapped and studied during this period. The routes taken by different species could be studied. Most of them travelled either by the Eastern route via Assam, Bangladesh and down the East

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Coast or by the Western route over Afghanistan, Pakistan, Saurashtra and the West Coast. During winter there was a large conglomeration of all these birds in and around several water bodies in South India and Sri Lanka where enough food and roosting place was available. Information was obtained on the migrating routes of different species. Recovery of a ringed bird or of its ring from distant places gave further confirmation, and in some instances gave an indication of the life span of the bird. The food sources and preferred roosting places, the associated climatic and environmental conditions were all recorded and a large amount of data accumulated for future analysis and study.

The initial camps were supervised by Sálim Ali himself, with the assistance of the BNHS staff. As work expanded and more camps were set up, some of these were run by the now well trained staff. Several research workers and interested volunteers also joined the camps. In this process, the assistants learned not only the techniques of bird trapping and banding, but also received a thorough grounding in the techniques of careful and meticulous field research. Some of Sálim Ali's early assistants have gone on to become leaders in natural history field research within the country. Reports on these studies have been published in the Journal of the BNHS.

The virus problem: The virus of KFD was identified and found to be similar but not identical with that of RSSE. The trapped birds did not show the presence of infection, and when tested for evidence of past infection, as shown by antibodies in the blood, the results were negative or equivocal. Reports of their findings are given in the published papers and the annual reports of the Virus Research Centre (now renamed the National Institute of Virology), Pune.

Discussion

The question of the origin of KFD virus remains. Two facts should be considered.

1. A Serological survey conducted all over India revealed a few samples from mature human individuals in an area of Saurashtra having antibodies to RSSE/KFD for which there appeared no explanation.

2. The insect vector for RSSE is a mite, whereas for KFD the vector is a tick.

It may be postulated that at some time in the past a bird or birds infected with RSSE landed in Saurashtra and shed infected mites, which in turn infected some humans in the adjoining village. The mites died out, unable to develop in the new surroundings, leaving as their only trace a few humans with antibodies to the disease.

What has happened once can happen again, the new scene being the Kyasanur Forest area. Here, though the mites died, the infection was taken up by ticks, possibly through the blood of an infected bird which lay dying on the forest floor. An arthropod borne virus is suited to one species of tick through which it is transmitted. If it enters the body of another species it either dies out or it undergoes some change or modification which enables it to propagate itself within the body of the new host. It may be assumed that the virus of RSSE entering the body of the tick underwent such a modification to form the closely allied virus of KFD. All this is speculation, but it appears to be the most plausible explanation which can fit the facts.

It is unfortunate that this sequence of events resulted in a new disease. At the same time, it is exciting to realize that we are privileged spectators of a small facet of the process of adaptation and natural selection which forms the basis of evolution of life on the earth.

CONSERVATION NOTES

EVOLVING A RATIONAL STRATEGY FOR AN INTEGRATED PROTECTED AREA SYSTEM IN MAHARASHTRA

E.K. BHARUCHA[1]

(*With two text figures*)

INTRODUCTION

An Integrated Protected Area System (IPAS) for biodiversity and natural resource conservation should form part of a rational land-use strategy for any region. This must take into account ecological aspects for the management of wilderness ecosystems, as well as the needs of local people who depend on natural resources for their subsistence. The relative importance of each Protected Area (PA) within the IPAS is related to their specific objectives. A Protected Area (a National Park or Wildlife Sanctuary) may support several important objectives or may have a limited role in the conservation strategy of the region. Primarily a PA is expected to preserve biodiversity and perpetuate the existence of all species within its communities. Those PA's that enhance these values are of greater importance than others that support objectives of secondary importance. A National Park with a large undisturbed core area would thus generally be of greater conservation significance than a small Wildlife Sanctuary with a limited goal such as supporting wildlife tourism or protecting a few large, conspicuous mammals.

The design and management of an IPAS requires :

a) Assessing the conservation status of its existing PAs.
b) Identifying specific objectives of each of the PAs.
c) Quantifying the level of sustainable resource-use by local inhabitants.
d) Providing rational criteria for the disbursement of funds, manpower and expertise based on the relative importance of each PA within the IPAS.
e) Using biogeographical criteria for selection of potential sites to be notified as additional PAs.

To develop a conservation strategy for an area, there is a need to design a system with clearly defined objectives for each PA. Protected Area management must consider their size, shape, zonation and most importantly their relative conservation status within the IPAS. The management plans of each PA must provide a strategy to support the resource needs of local people living within and around the PA's. It is also essential to select the biologically most appropriate sites to notify new areas as PAs for inclusion in the IPAS.

AIMS AND OBJECTIVES

This paper attempts to formulate guidelines for designing an IPAS for Maharashtra State, which has 29 Protected Areas. These have been established over the years without considering the conservation status of the area or assigning specific objectives for their management. No attempt has been made to develop them into a network of Protected Areas based on objective criteria. This paper thus focuses on establishing:

i) the biological values and the conservation potential of existing PAs ;
ii) the socio-economic milieu within these PAs, with a view to assess the levels of utilization of resources as against the conservation goals of the area ;
iii) Assessing the level of people-wildlife conflict.

This paper describes a rapid method to evaluate and compare the PAs and to assign a relative position for them in the present network. It takes into account their specific objectives as well as the present conservation status of each Protected Area. This would help to rationalize the distribution of funds and manpower for each PA in relation to its rating in the IPAS.

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Part A of the paper thus states the possible range of objectives of each PA. It describes the number and size of existing PAs in different biogeographical areas of the State. It provides guidelines for rationalizing the allocation of land necessary to establish an IPAS that gives due weightage to the proportion of distinctive ecological systems in Maharashtra. The impact of resource use on PAs is analyzed and the pattern of conflict between conservation and utilization of resources in the PA is discussed.

Part B is aimed at ascribing 'notional values' for assessing the relative importance of each of the PAs within the IPAS. This gives due consideration to :

a) Bio- geographical and other biological values ;
b) The possibility of enhancing resource-use for local people through eco-development schemes; and,
c) An assessment of conflict between conservation and utilization.

These three parameters are graded for each PA to provide basic guidelines for their management. The management options that are suggested are related to the specific objectives of each of the PAs in the IPAS.

METHOD

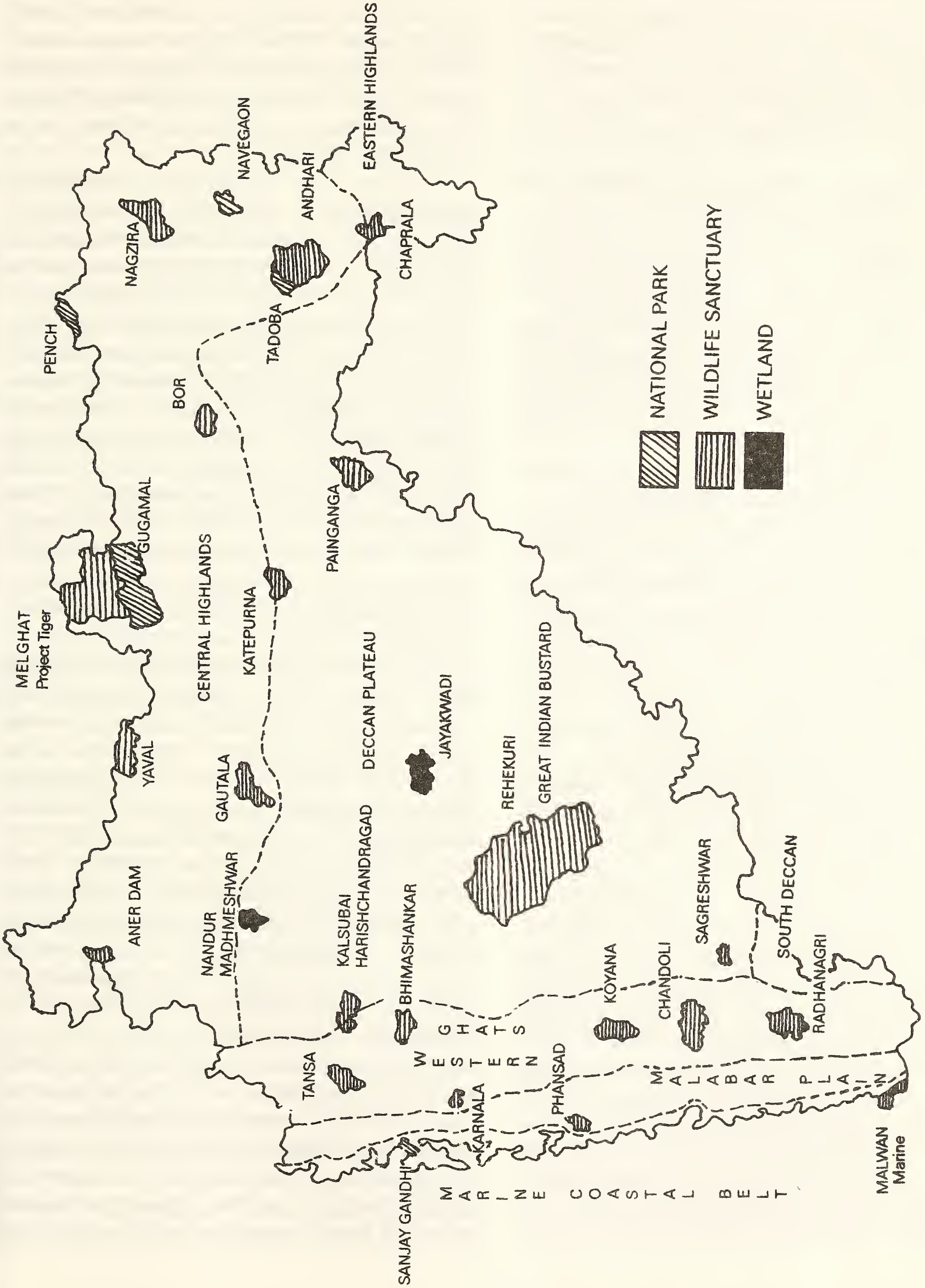
A review of the conservation status of the 29 PAs in the State of Maharashtra has been made. A random field study of sixteen of the Protected Areas was done to evaluate their present status and rank the relative importance of each PA. Data have been collected from the 29 Protected Area Managers through several questionnaires (See Annexure 1 and 2 for examples). The major and minor perceived objectives of each PA have been identified. The area included in the PAs have been related to the proportion of the different biogeographic landscapes and their ecosystems found in the state of Maharashtra. The size, shape, conservation status, and ecological categories of each PA and the presence of corridors have been evaluated. The pattern and intensity of local resource use, and the potential to reduce this pressure through ecodevelopment has been considered. Further the level and nature of conflict in each PA has been studied. These parameters have been used to grade PAs on a comparative scale using notional values for each parameter. The paper thus uses a method to gradually increase the sensitivity of notional values through gradual steps that take into account easily quantifiable parameters, which is then integrated into more complex concerns where quantification is less evident. Thus notional values of earlier tables in Part A have been used to improve the objectivity of the notional values used in Part B.

DISCUSSION

PART A

Protected Areas are essentially established as a part of developing a rational land-use strategy to preserve biological diversity. To maximize this output for any area it is essential to devise an Integrated Protected Area System or a network of representative areas of different forms of wilderness found in a region.

Long-term planning for conservation requires a national or regional overview of residual wilderness, and remoteness and naturalness referred to as 'primitiveness' are the two environmental attributes that determine wilderness quality (Lesslie *et al.* 1988). The estimation of total wilderness quality by summing together four wilderness indicator values is used. They, however, stress that this rests on the assumption that the indicators themselves contribute equally to total wilderness quality, and that 'a unit of measurement or rating class for one indicator has equivalence with that for another. This paper also uses a similar system which has a greater degree of discrimination in placing values on different criteria. The specific conditions in India (and for this a case study for Maharashtra), which has great variations in biogeographic patterns, necessitates a finer grading for assessing the overall rating of PAs. This paper presents a more rational and sensitive method of evaluation. Lesslie *et al.* (op. cit.) also stress that there should be a weightage provided for 'perceived


MELGHAT
Project Tiger
GUGAMAL
PENCH
NAGZIRA
NAVEGAON
EASTERN HIGHLANDS
ANDHARI
CHAPRALA
TADOBA
BOR
PAINGANGA
CENTRAL HIGHLANDS
KATEPURNA
DECCAN PLATEAU
JAYAKWADI
REHEKURI
GREAT INDIAN BUSTARD
YAVAL
GAUTALA
ANER DAM
NANDUR
MADHMESHWAR
KALSUBAI
HARISHCHANDRAGAD
BHIMASHANKAR
WESTERN GHATS
TANSA
KARNALA
PHANSAD
KOYANA
CHANDOLI
SAGRESHWAR
SOUTH DECCAN
RADHANAGRI
MALABAR PLAIN
MALWAN
Marine
SANJAY GANDHI
MARINE COASTAL BELT
▨ NATIONAL PARK
▥ WILDLIFE SANCTUARY
■ WETLAND

PROTECTED AREAS OF MAHARASHTRA

importance'. A similar parameter has also been used in the present paper and is referred to as the 'potential value' of a PA. This, however, cannot be used in isolation as its actual value is a combination of its potential with issues such as effectiveness of management and the level of conflict due to resource use.

'Hot Spots' of biodiversity at global and national levels have been identified for inclusion into PA systems. An important feature even at regional level is to include locally identified 'hot spots' as PAs. Using Myers' (1988) classification of a 'Hot Spot' at the regional level, one should include those areas that are: '(a) Characterized by exceptional concentrations of species with high levels of endemism and (b) are experiencing unusually rapid rates of depletion.'

Myers' (op. cit.) statement that "This would help concentrate attention where needs are greatest and where the pay-off from safeguard measures would also be greatest" can thus be applied to provide a rule of thumb for identification and prioritization of conservation efforts in a group of PAs. Myers (op. cit.) stresses that the use of "working estimates" acts as a sound support to prioritize or select areas as "hot spots", in the absence of statistical information. Thus some data if gathered fairly objectively on a comparative scale is better than waiting till field studies and quantified estimates, that take a long time, are made. In critical situations this may amount to a delay by which time several species become extinct. According to Myers' (op. cit.) 'its cause tends to go by default.' He also claims that the "islanding effect" makes it possible for a park to safeguard only 50% of its original species complement, which must constitute 10% of the original expanse of habitat. It is also claimed that due to "ecological equilibration" there is a delayed fallout of species. This indicates that for most of our biogeographical landscape forms, the prospect of maintaining or holding the level of biodiversity in Maharashtra is poor. At the present rate of degradation biological values are bound to deteriorate, unless management is significantly improved.

As pointed out by McNeely (1994), for maintaining biodiversity there should be "a well managed system of PAs established in each country, including representative ecosystems and the widest possible range of a country's biodiversity." This is of equal importance at the regional level, i.e. in the individual states of India.

Wilderness can be classified in several ways, which facilitate the inclusion of representative landscape elements in the PA network. As stated by Presley and Logan (1994) " Land classes such as vegetation types, ecoregions, or environmental domains can be defined in many ways and at many scales." Providing a Classification is complex, as it is related to the multiplicity of elements present in a particular landscape pattern, especially as there is an added element in the mosaic produced by different levels of biotic pressure. It has been stated that " Reserve Coverage (the percentage of land classes represented in reserve systems) usually changed as the classes were defined more finely." Presley and Logan (1994) thus devised a system to ensure the inclusion of all important forms and their components. They have suggested a variety of *caveats* on the uses of land classes for judging reserve adequacy. This variable is expected to rely on more complex deliberations than measurement of coverage. They state that "...threshold areas for calling land classes 'reserved' are essentially arbitrary and indicate nothing about the viability of reserved populations (Leader-Williams *et al.* 1990), the status of source and sink areas (Pulliam 1988), landscape context and disturbance regimes (Moss 1987, Baurgeron 1988)..." Many regions have a mosaic of landscape forms with several sub-types. All land classes are said to be heterogeneous, both physically and biologically, they must also be accompanied by information on rare or patchily distributed taxa (Scott in Presley and Logan 1988). The different land classes are not equally important reservation sites as "those most at risk by extractive uses are most urgent candidates for the strictest protection." This is extremely relevant to our local conditions where most PAs support the biomass needs and fodder supplies of local people. They conclude that "assessments of reserve coverage should therefore place much more emphasis on *which* land classes, rather than how many are to be preserved. Otherwise a high percentage of land classes represented could mark the frequent bias in reserve systems toward environments with low potential for major commercial use" (Presley and Logan 1988).

Several authors stress the importance of including rare species or relict ecosystems. The abundance and rarity factor depends on the size of a region under review. Hunter *et al.* (1994) have stated that "range size and local abundance are *not* independent. Local abundance is very variable. Therefore rarity must be examined in the context of the entire spatial distribution of abundance within the range carried away by local rarity." These authors also focus attention on the fact that it is incorrect to allocate relatively large sums to species that are only rare locally, while species threatened with global extinction receive far less funding (Hunter and Hutchinson 1994).

The other major aspect of developing an IPAS is the use of a graded evaluation scale for individual PAs which is based on a set of objective criteria. The conservation status of a PA is related to its relative importance within the group of PAs of an area. As the most important objective of conservation is the preservation of biodiversity it is essential to define the parameters that should be used for biodiversity assessment. The 'value' of biological diversity must include not only the variety of species found in an area but also the range of landscapes, natural communities, ecosystem types, the extent of endemism and the number of rare or threatened species.

In a situation in which there has already been an ad hoc selection of PAs, as in Maharashtra, identifying new PAs must be done with relevance to the existing network, to maximize biodiversity (Margules, Nicholls and Pressey 1988). They must include not only all possible species but all possible ecosystems or biogeographically unique areas. According to them this must include diversity, rarity, naturalness, size and representativeness. Including those areas that have rare species is of great concern. They also suggest that species poor systems are likely to have less unique species. It, however, also provides examples to demonstrate that size alone is not a satisfactory (or should not be the only) criteria by which PAs can be evaluated. The authors recognize that many of these discussions are based on pragmatic rather than on scientific grounds.

To allocate manpower and funds for management for PAs it is imperative to grade each PA on as objective a scale as possible. Wright (1977), reviewed several such scales. Workers such as Scott *et al.* (1987) argue that though PAs may have been initially selected to preserve large mammals or a few publicized bird species, they have inadvertently protected habitats and all their component species through better (although inadvertent) protection of the landscape.

Scott *et al.* (1987) state that the framework for the preservation of species ought to be fought at five levels in the landscape (Noss 1983): ecosystem, community, species, population and individual. Their paper stresses that "costly attempts at preserving much publicized individual endangered species may have a lower impact on the preservation of biological diversity than efforts to develop a rational management for groups of PAs within an area by managing ecosystems". Information on biological values of PAs coupled with data on trends in surrounding land-use patterns and management practices are all essential for developing a viable IPAS (Scott *et al.* 1987). These authors suggest that "there is less expense and more chance of success if extinction is fought by maintaining self-perpetuating populations of more common species. Species must be prevented from becoming endangered rather than to try to revert the process of endangerment." The present analyses suggest that prevention of ecosystem degradation is better than attempts at cure. It suggests that a multi-parameter assessment of individual PAs, and thus a successful management strategy of an IPAS alone will prevent extinctions in the long term.

Wilson (1992) eloquently expresses that if we went long enough to collect large quantums of

BOX 1

PROTECTED AREA OBJECTIVES

Each PA has several interlinked objectives which may be considered to be of primary, secondary or tertiary importance in achieving the goals of the IPAS.

(1) Preservation of the various biotic features of natural ecosystems, for protecting genetic resources and processes *in situ* and to preserve biodiversity at population, species, community and ecosystem levels. Special protection must be provided for known threatened or endangered plants and animals.	Primary
(2) Preservation of ecological processes of the natural ecosystem for:	
(a) Retaining soil	Secondary
(b) Stabilizing water regimes	Secondary
(c) Climate control at micro-level	Tertiary
(d) Contribute towards reduction of water and air pollution and global effects such as recycling of C_2 and CO_2.	Tertiary
(3) Conserving resources for local people and other groups:	
(a) Non-marketed - Consumptive and substinence resources such as food, fuel, fodder and non-wood products.	Secondary
(b) Marketed products - Small timber, non-wood products, honey, resins, roots, fish, etc.	Secondary
(c) Tourism - Recreational facilities.	Tertiary
(d) Opportunities for education and research	Tertiary
(4) Perpetuating 'existence' value: preservation of national and global heritage sites for the 'common good' of people for emotional, esthetic or ethical reasons.	Tertiary

Note: Without achieving the secondary goals, the PA's ability to reach its primary objectives is frequently doubtful. Their importance is thus not appreciably lower than those of the primary objectives. Tertiary objectives usually contribute in a limited way towards global environmental conditions or may benefit only a small specific section of society.

data it may be too late to preserve biodiversity, as there is only "one planet, one experiment". Thus rapid evaluation and immediate actions are of crucial importance.

The range of species, their population density, vegetation types, etc. forms the baseline data for selection of new sites, for modification of boundaries, for the application of management criteria, and to disburse funds for PAs. Those PAs that contain a larger proportion of rarer species or communities must undoubtedly be provided with a greater level of protection. There is little data to show the proportion of each vegetation type as classified by Champion and Seth within existing PAs of Maharashtra. Vertebrate species richness is said to be a good indicator of overall natural diversity. Vertebrate niches are shaped by a complex of biotic, abiotic, and cultural factors, such as the complexity of the community food web, total available biomass, and vegetation structure and productivity. There is evidence to show that there is a high correlation between vertebrate species-richness and overall natural diversity (Scott *et al.* 1987). This paper utilizes vegetation patterns as indicators of threatened systems and the known species richness of major vertebrates, as indicators of the value of each PA in Maharashtra.

Status of PAs in Maharashtra

For the locale specific issues related to Indian conditions, as for most other developing countries of the South, the conservation importance of a PA can be judged on three separate scales, each consisting of different parameters. These are :

(I) Based on their specific objectives;
(II) Based on landscape types; and
(III) Based on interactions between biotic pressures and management patterns.

I. PA OBJECTIVES

The 'perceived' objectives for establishing PAs such as the preservation of wildlife and nature, and to encourage wildlife tourism, are well known. However, a clearer perspective of the specific conservation objectives of each PA must be identified. Each PA has a group of more important, i.e. primary objectives and other objectives that can be considered of secondary or tertiary importance (See Box 1). A Protected Area's management should be aimed at achieving all its potential goals. Success in meeting perceived objectives, however, varies in relation to management and conflict levels.

PROTECTED AREA OBJECTIVES

The conservation objectives must include the protection of biodiversity, preservation of life support systems and the sustainable use of renewable resources within the regeneration capacity of its ecosystem. One of the objectives of Protected Areas is to develop a strategy to conserve the earth's "vitality and diversity" (Caring for the Earth. IUCN-UNEP-WWF-1991, p. 9). The buffer area of a PA should form a model for 'sustainable use' of resources, which can be replicated in areas outside PAs.

The PAs have global, national, regional (state) or sub-regional goals for conservation of biological diversity, and a variety of other natural resources and ecosystem services. The most important objective of PA management must be aimed at maintaining or enhancing its conservation prospects for preserving biological diversity. This is categorized as a primary objective. Preserving fragile ecosystems and / or preventing extinction of a specific species may constitute the other primary objectives of a PA.

Utilitarian objectives of National Parks or Wildlife Sanctuaries have a wide spectrum ranging from those that are beneficial to society at a global or national level, to the utilization of resources for restricted groups of society living within or adjacent to the PA. These are frequently secondary goals.

At a global level the forest PAs are said to contribute towards modifying climate, photosynthesis, or pollution. Another wide ranging benefit that has major implications for society at large, is to provide opportunities for research and education that broadens the scope of bio-sciences and gives new insights into the value of preserving Nature.

At a National level, PAs protect economically valuable 'gene pools' of animals and plants essential for genetic engineering. This is the potential raw material for the breeding of domestic animals and for the development of new cultivars. This financial implication for preserving biodiversity has now become one of the most important reasons for conserving genes, species and ecosystems *in situ*. Identifying new drugs and industrial products from the wilderness will indeed become a major national incentive to maintain PAs.

At the local level the PA's objectives may also be aimed at benefiting people living some distance away from it as well as those who live in and around it. The watershed protection afforded by a forest PA decreases peak runoff in the monsoon and prolongs the flow of water in summer. This supports urban and rural agricultural settlements downstream (Gadgil 1987). Wetland PAs act as flood buffers for surrounding areas. Grassland PAs can produce fodder for stall feeding domestic stock around the PA. The objectives of the PAs thus necessarily include supporting the needs of the local people. Its 'social' buffer should be capable of producing directly utilisable renewable resources such as fuelwood, fodder, M.F.P. and marketable products on a sustainable basis. If this objective is not achieved, the PA cannot be expected to have a long term viability. Functions such as wildlife tourism serve the needs of a more limited segment of society, i.e.

those who visit it for recreational purposes (McNeely 1988, p. 21).

In Maharashtra, Forest PA's, such as Bhimashankar and Radhanagari in the Western Ghats are believed to harbour a high level of species diversity of plants and animals. The specific objectives of these important PAs thus place a great stress on maintenance of their gene pools (India: Conservation of Biodiversity WCMC).

An important objective of PAs such as Nagzira, Tadoba or Sanjay Gandhi National Park, that have large accessible populations of major mammals and forests which are visited by a large numbers of people, is wildlife/ecotourism. These PAs are thus potential sites for nature education through Interpretation Centers and Nature Trails.

The prevention of siltation of lakes due to erosion in the catchments of Koyna, Tansa, Sanjay Gandhi National Park, and Pench is an important objective of these PAs as this aspect has great economic implications.

A less frequently discussed objective of the wetland PA's of Nandur and Jayakwadi is their ability to be managed as "Multiple Use Areas". This function is linked to the survival of these PAs as carefully selected human activities do not negate their specific conservation objective of managing wetlands for conservation of waterfowl (Bharucha and Gogate 1990). This last group of spatially oriented objectives is related to the geographical and ecological conditions in which the PA is located.

The important criteria for rating PAs can thus be based on the relative importance of their perceived objectives. However, PAs may have different levels of success in meeting their objectives. Several management related issues must be taken into account to assess the potential of a PA in achieving its predetermined objective. PAs in which management is successful in meeting objectives would thus have to be given a higher rating in the IPAS. This must take into account not only the potential of a PA to act as a biological 'gene bank' at present, but its capacity through successful management to retain its wealth in the long term. This is related to the competence with which it is managed and the level of pressure on its resources. The species diversity found in some of these PAs should be carefully inventoried and quantified, as they are potentially valuable national and even globally important 'Hot Spots' of biological diversity. This is of great importance in the biologically rich PAs of the Western Ghats such as Bhimashankar, Koyna and Radhanagari.

II. LANDSCAPE TYPES

The PAs can be categorized into different landscape types, each of which have a set of specific characteristics. These are related to biogeographical features and differential levels of biotic influences. A landscape 'type' is also a reflection of the biotic province, the ecosystem, the size of the 'island' of wilderness notified in the PA, its shape and corridors connecting it to neighboring PAs.

BIOGEOGRAPHICAL FEATURES

a) Area included in the PAs of Maharashtra :

Table I shows that of the 3,07,690 sq. km of Maharashtra, 15,384 sq. km are at present within the PAs, i.e. 4.9% (Rodgers and Panwar 1988). However 8,496 sq. km of the area within PAs constitutes a single PA - the "Great Indian Bustard Sanctuary". This consists of predominantly agricultural land and includes the city of Solapur within its boundaries! As only about 400 sq. km of this PA is of significance for the protection of the Great Indian Bustard, the 8,096 sq. km of its agricultural area should not be considered to be of conservation significance for the PA network of the State. This leaves 7,288 sq. km within the viable existing network and constitutes only 2.3% of the landmass of Maharashtra.

b) Ecological categories:

An IPAS must reflect the proportion of distinctive biogeographic areas within the State. The

TABLE I
AREA WITHIN BIOTIC PROVINCES AND IN THE PA NETWORK

Biotic Province	Total landmass of Maharashtra (sq. km)	(A) % in each biotic province	Area under PA at present (sq. km)	(B) % of area in PA network	Area in PA if GIB reduced in size	(C) % of area in PA network reduced GIB
Western Ghats	3,000	10.00	1,993	12.90	1,993	27.30
N & N.E. Forests	40,000	12.90	4,086	26.50	4,086	56.06
Deccan Plateau	2,13,000	69,20	8,606	55.94	510	6.99
Konkan Plain and Coast	23,800	7.80	99	0.64	99	1.35
(Wetlands)	*3,000	—	600	3.90	600	8.23
TOTAL	3,07,800		15,384		7,288	
% of total land area			(4.9)		(2.3)	

* Not used in calculation as this is included in the terrestrial system
GIB - Great Indian Bustard Sanctuary; N & N.E. Forests - (Central Highlands) - North and North East Forests.

PAs can be divided into those that are established to protect terrestrial and aquatic systems. The terrestrial ecosystems constitute forests of different types (evergreen, moist deciduous, deciduous and thorn forests) as well as other ecosystems such as grasslands and scrubland in semi arid areas. The 3000 sq. km of wetlands in Maharashtra are associated with different terrestrial ecosystems in the State (Conservation of Wetlands in India - June 1989). In the PA network 600 sq. km of wetland is notified as PAs in the backwaters of two Irrigation Projects. The small but biologically valuable residual patches of mangrove found along the coast have not been included in the present PA network. (Conservation of Mangroves in India - August 1990). In most cases, they are not under the jurisdiction of the Forest Department and have even been classified as ‘wasteland’! Only one marine system has been included in the PA network.

The PAs of Maharashtra have been grouped at a National level into three distinctive zones and four provinces (Rodgers and Panwar 1988). This includes : i) the deciduous hill forests of the North and North East region (which are called the Central Highlands of India); ii) the forests of the Western Ghats; iii) the grasslands of the semiarid Deccan; iv) the Konkan and coastal belt and v) the wetlands.

Table I shows the relative proportion of each region in the total landmass of Maharashtra - (A) (Rodgers and Panwar 1988). The area at present in the PA network in each biotic province and the percentage represented in the network - (B) and the percentage if the GIB sanctuary is reduced to 400 sq. km - (C) which is only 2.3%. Thus, within the network, a major proportion is represented in the Great Indian Bustard Sanctuary. However, if it were to be reduced in size, the residual PA network would be only 7,288 sq.km (Fig. 2.).

Though the percentage of area in the PA network - (B) appears to be representative of the State’s biogeographic regions, it is effectively as shown in - (C), i.e. with a reduced GIB, which represents the viable area in the conservation network. The gross disparity in the proportion of land between the area in each Biotic Province as seen in - (A) & (C), i.e. if the GIB were to be reduced in size, is evident. The 69.2% of land in the State which is in the grasslands of the Deccan and that which is represented at present in the PAs is 55.9%. However, if the agricultural land in the

GIB sanctuary is excluded the total percentage of grassland within the IPAS would be only 6.9% which is thus a gross under representation. Whereas the N and NE region constitutes 10% of the total landmass of Maharashtra, it is over represented at present, constituting 26.5% of the PA network and would cover as much as 56.06% of the IPAS if the GIB sanctuary is reduced to a manageable size. This would make this forest system highly over represented. The highly fragile and species rich Western Ghats has a small proportion - 10% in the landmass of the state. This has a special conservation significance as a 'Hot Spot' of biodiversity. At present, it has 12.9% in the PA network, which would be 27.3% if the GIB Sanctuary is reduced in size. However it may be essential to include larger areas of the Western Ghats to protect this ecosystem and establish corridors between these PAs as they are Ecologically Sensitive Areas. Reducing the GIB Sanctuary in size would decrease the percentage of land in the IPAS from 4.9% to a meager 2.3%. This would have to be increased by including newly identified biologically appropriate areas.

In Table II, Columns B minus A, and C minus A provide an index of the extent of spatial over/under representation in relation to the relative proportion of the biotic provinces in the State. C minus A shows the degree of imbalance in the representation with an over representation of PAs in the forests of the North and North East (C-A = 43.16) and an under representation in the semiarid Deccan plateau (C-A = -62.21). Here it may be stressed that the biogeographic classification of India suggested by Rodgers and Panwar (1988) places this semiarid biotic province in a specific category which is restricted to Maharashtra. It thus has a national significance. These semiarid tracts had a variety of wildlife such as the Blackbuck, Chinkara, Wolf, Great Indian Bustard, Raptors, etc. which are now disappearing. This ecosystem has been converted through irrigation into an extensive farmland mainly for sugarcane, and the residual

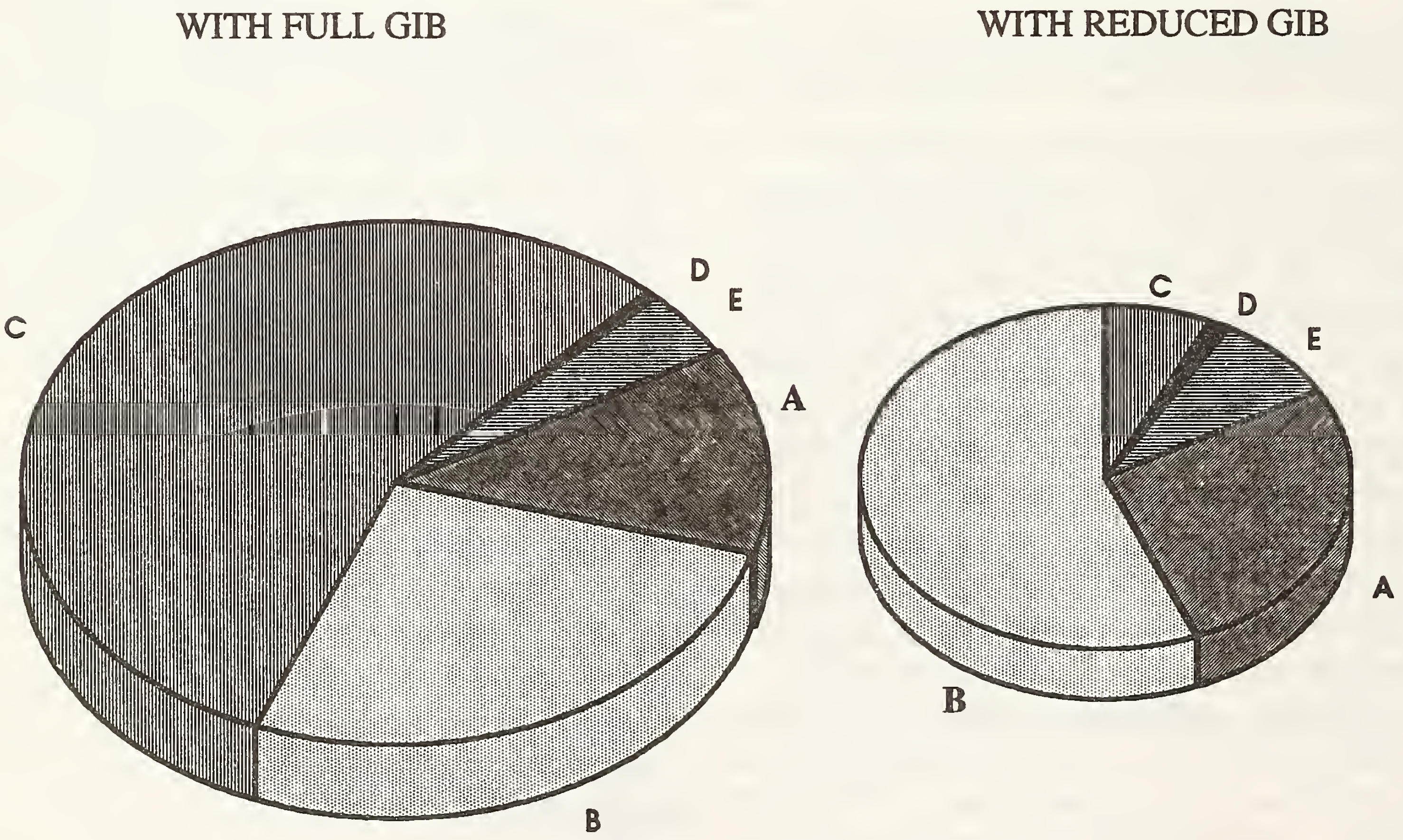


Fig. 2. Representation of Biotic Provinces in Maharashtra and in the PA network.
A - Western Ghats; B - North & NE Forests; C - Deccan Plateau; D - Konkan Plain & Coast; E - Wetlands.

Table II
PROPORTION OF BIOTIC PROVINCES IN THE STATE AND IN THE PA NETWORK

Biotic Province	% in biotic provinces in the state	% in PA network at present with full GIB	Over (+)/Under(-) representation on spatial basis	% in PA network if GIB is reduced	Over (+)/Under (-) representation on spatial basis	Notional value
	A	B	B-A	C	C-A	
Western Ghats	10.0	12.90	(+2.90)	27.30	(+17.30)	2
North & N.E. Forests	12.9	26.50	(+13.60)	56.06	(+43.16)	1
Deccan Plateau	69.2	55.94	(-13.26)	6.99	(-62.21)	3
Konkan Plain & Coast	7.8	0.64	(-7.16)	1.35	(-6.45)	3
Wetlands	—	3.90		8.23		2

*Based on size only. No values provided for conservation importance.

grasslands are over-grazed by the growing cattle population. This short grass system which in its undisturbed form, supported a large diversity of grasses and forbs is now being rapidly degraded. Those areas that still resemble the 'natural' grassland ecosystem require urgent protection by including them in the IPAS as new PAs. In evaluating the importance of a PA this can be used to provide a higher notional value for those systems that are under represented and have a 'minus' representation, and a lower notional value for 'plus' representations.

Though the amount of land in each biotic province constitutes a rationale for the percentage to be protected in each ecosystem within the IPAS, due importance must be given to a variety of other factors. An ecosystem approach is essential to provide a greater degree of protection for the preservation of distinctive landscapes or habitats and their component biotic communities (Table III, Fig. 2). A relatively larger representation in the IPAS must be provided for areas of national and international significance, i.e. for their uniqueness, or for those which are being rapidly degraded or converted to other uses. (IUCN: Conserving the World's Biological Diversity, 1990). In Maharashtra the fragile forest ecosystems of the Western Ghats fulfill these criteria (Rodgers and Panwar 1988, p. 199). To ensure their long-term viability, the PAs in the Western Ghats must be increased in size and be provided with a National Park status instead of being classified as Wildlife Sanctuaries. A change to National Park status for selected high value PAs would give them a higher level of protection. These should, wherever possible, be linked to each other through Reserved Forest or PA corridors. If these PAs are managed so as to constitute an interconnected chain, the needs of evolutionary processes are more likely to remain intact for a variety of endangered flora and fauna. Several Reserved Forest patches have been identified to provide such a continuous linkage. *Deorais* (Temple Groves) could form 'cluster' PAs of great conservation significance for endangered and endemic plants. These have patches of 'old growth' forest with high species richness. These have been maintained as intact plant communities which have been preserved due to local sentiments.

In the Konkan, the seashore, the mangroves, as well as the vegetation of the plain has been poorly represented (Rodgers and Panwar 1988, Vol.I, p. 204). New PAs for this region must be notified as early as possible as residual natural areas are being increasingly converted to other types of land use.

The various forest types and ecosystems in the PAs is given in Table III. This shows that there are only three PAs with evergreen vegetation, ten have semi-evergreen forests, fourteen have moist-

Table III
PAs IN MAHARASHTRA - TYPES OF ECOSYSTEMS

S.No.	Name	Status	Size	Biotic Province	Description	No. of PAs
1	Radhanagari	WLS	372	WG	Evergreen, semi evergreen, moist decid.	
2	Kalsubai	WLS	362	WG	Evergreen, semi evergreen, moist decid.	
3	Bhimashankar	WLS	131	WG	Evergreen, semi evergreen, moist decid.	3
4	Koyna	WLS	424	WG	Semi-evergreen, moist deciduous	
5	Chandoli	WLS	309	WG	Semi-evergreen, moist deciduous	
6	Tansa	WLS	305	WG	Semi-evergreen, moist deciduous	
7	Sanjay Gandhi	NP	86	WG	Semi-evergreen, moist deciduous	
8	Karnala	WLS	4	WG	Semi-evergreen, moist deciduous	
9	Phansad	WLS	70	C	Semi-evergreen, moist deciduous (and mangrove)	
10	Chaprala	WLS	135	N & NE	Semi-evergreen, moist deciduous	7
11	Melghat	WLS	1,597	N & NE	Moist deciduous, dry deciduous	
12	Gugamal	NP	362	N & NE	Moist deciduous, dry deciduous	
13	Pench	NP	257	N & NE	Moist deciduous, dry deciduous	
14	Nagzira	WLS	153	N & NE	Moist deciduous, dry deciduous	
15	Andhari	WSS	509	N & NE	Dry deciduous	
16	Painganga	WLS	325	N & NE	Dry deciduous	
17	Gautala	WLS	261	N & NE	Dry deciduous	
18	Yawal	WLS	178	N & NE	Dry deciduous	
19	Navegaon	NP	134	N & NE	Dry deciduous (and lake)	
20	Tadoba	NP	117	N & NE	Dry deciduous	
21	Bor	WLS	61	N & NE	Dry deciduous	11
22	Sagareshwar	WLS	11	DP	Southern thorn forest	1
23	GIB	WLS	8,496	DP	Grassland, scrubland	
24	Aner Dam	WLS	82	DP	Grassland, scrubland	
25	Katepurna	WLS	15	DP	Grassland, scrubland	
26	Rehakuri	WLS	2	DP	Grassland, scrubland	4
27	Jayakwadi	WLS	400	W	Wetland (and scrubland)	
28	Nandur-Mad.	WLS	100	W	Wetland (and moist decid.)	2
29	Malvan	WLS	29	M	Mangrove, coral reef & coastal scrub	1

WLS = Wildlife Sanctuary (24) NP = National Park (5)
WG = Western Ghats (8 PAs) N & NE = North & North East Forests (12 PAs)
DP = Deccan Plateau (4 PAs) W = Wetland (2 PAs) C = Coast (1 PA)
M = Marine (1 PA).

deciduous forests and eleven have deciduous forests. However, the area within most of the forest systems consists of large tracts of dry deciduous forests with a smaller representation of moist-deciduous vegetation and semi-evergreen components. The extent of evergreen patches is extremely limited and should be provided with an especially important status in the network.

The three PAs that have evergreen, semi-evergreen and moist deciduous forests include only 865 sq.km. Semi-evergreen and moist deciduous forests in 7 PAs cover 1333 sq. km. Moist and dry deciduous include 2369 sq. km. in 4 PAs. Purely dry deciduous forests cover 1585 sq. km in 7 PAs. One PA has thorn forest, 4 have grassland or scrub with 8595 sq. km, two are wetlands and one is marine. Table III.

c) Conservation Status :

Of the 29 PAs in Maharashtra, only one is fully notified. (Management of National Parks and Sanctuaries in India, 1989, p. 9). The absence of full notifications have serious implications in terms of management.

Out of the 29 PAs, only 5 (17%) have National Park status. The remaining 24 (83%) are Wildlife Sanctuaries and have a lower conservation status Table IV. Their status as NPs and WLSs, however, does not reflect their relative conservation importance among the Protected Areas. The functions of these NPs and WLS's do not conform with existing IUCN norms which would consider most of them as "Multiple Use Areas" (Ledec and Goodland 1988, p. 166-171). Settlements are found in 28 of the PAs and resources are used by the people both legally and illegally. This impact is unlikely to be reduced without a participatory approach to management where local people are involved and benefit from the PA.

In the past PAs were established on an ad hoc basis with a view to protect their major mammal species. The need to protect ecosystems, critically endangered habitats, visually insignificant species that are threatened by extinction, or areas of unique national or international significance, has only been appreciated in the recent past. Criteria for selection of new areas and for modification of the boundaries of existing PAs are essential to develop a long-term conservation strategy for Maharashtra.

(d) Size of PAs:

The potential to preserve a larger diversity of plant and animal species is generally greater in PAs of a large size. (Wilson 1992). As human population is expanding at a rapid rate, it is not feasible to allocate new areas for conservation. The size distribution of PAs in Maharashtra shows that 11 are between 250 and 1000 sq. km; 6 are between 100 and 250 sq. km while 10 are small, being below 100 sq. km in size (Table IV). Several of these PAs must be increased in size especially in the more fragile ecosystems which have a high species diversity to achieve important conservation goals. The relict forests of the crest line of the Western Ghats which are found in only a few residual patches must all be protected by large surrounding areas of forest on either side of the crest line. This would reduce the impact of surrounding human pressures on them.

The extremely large "paper" GIB sanctuary, however, could be effectively reduced to about 400 sq. km. Changes in the boundaries of some PAs are essential either to include adjacent forest or to exclude highly degraded areas of little conservation value. The size of a PA is closely related to its objectives. Protected Areas for conserving a rare plant could be perfectly adequate even if it covers only a few square kilometres. For conserving a species such as the tiger, a 250 sq. km sanctuary may be too small. Thus the intention to denotify a large part of Melghat, even though it includes several villages, is a highly damaging action for the conservation of the tiger and its shrinking habitat in the State. Providing notional values purely on the basis of size shows that thirteen PAs are over 250 sq.km in size and have a value of '3', six PAs are between 100 to 250 sq.km and are given a value of '2' ; while ten PAs are less than 100 sq.km and have been given a value of '1'.

The debate on whether to have several small reserves or a few large ones is difficult to resolve and has been called the SLOSS problem (single large or several small). This needs to be appreciated on a case to case basis (Wilson 1992).

TABLE IV

SIZE DISTRIBUTION OF PAs IN MAHARASHTRA

Sr. No.	Name	Status	Size (sq. km)	Notional value
Category I A - 1000 sq. km and above				
1.	GIB	WLS	8,496	3
2.	Melghat	WLS	1,597	3
Category I B - 250 sq.km to 999 sq.km				
3.	Andhari	WLS	509	3
4.	Koyna	WLS	424	3
5.	Jayakwadi	WLS	400	3
6.	Radhanagari	WLS	372	3
7.	Kalsubai	WLS	362	3
8.	Gugamal	NP	362	3
9.	Painganga	WLS	325	3
10.	Chandoli	WLS	309	3
11.	Tansa	WLS	305	3
12.	Gautala	WLS	261	3
13.	Pench	NP	257	3
Category II - 100 sq.km to 249 sq.km.				
14.	Yawal	WLS	178	2
15.	Nagzira	WLS	153	2
16.	Chaprala	WLS	135	2
17.	Navegaon	NP	134	2
18.	Bhimashankar	WLS	131	2
19.	Tadoba	NP	117	2
Category IIIA - 25 sq.km. to 99 sq.km.				
20.	Nandur Mad.	WLS	100	1
21.	Sanjay Gandhi	NP	86	1
22.	Aner Dam	WLS	82	1
23.	Phansad	WLS	70	1
24.	Bor	WLS	61	1
25.	Malvan	WLS	29	1
Category IIIB - 1 sq.km. to 24 sq.km.				
26.	Katepurna	WLS	15	1
27.	Sagareshwar	WLS	11	1
28.	Karnala	WLS	4	1
29.	Rehakuri	WLS	2	1

N.B. WLS = Wildlife Sanctuary; NP = National Park.

(e) Shape of PAs :

Ideally, a PA should have as regular a perimeter as possible. In most of the PAs in Maharashtra the borders appear to have been delineated so that the PA can be easily administered. Frequently, little thought seems to be given to the inclusion of complete ecosystems or a complete mosaic of important components of the 'landscape type'. Inclusion of buffer areas for the PAs has also been neglected. There are PAs with several villages within them, while areas of vitally important neighbouring forest have been left out of the notification. A re-demarcation of the boundaries of some of the PAs is essential. A contentious issue is whether to include or exclude settlements lying geographically within a PA during notification. It is becoming increasingly apparent that re-location of these settlements is impossible due to paucity of land. Thus it may be administratively more appropriate to notify the area along with the villages and to ensure that eco-development becomes a part of the management of the PA. The ratio of the circumference to the size of the PA is an index of its regularity. The smaller the perimeter, the more compact and manageable the PA. Reliable data on the perimeter of each PA is not available.

(f) Corridors for PAs :

To improve the ability of PAs to support genetic and evolutionary processes, they should be linked to each other, if possible, through corridors. This is especially important in the species rich Western Ghats. Notifying existing Reserved Forest patches in this area as Wildlife Sanctuaries should be attempted between Bhimashankar and Koyna and could extend further south to link Chandoli and Radhanagari. The notification of the proposed Fr. Santapau Sanctuary would have great conservation importance for the state. Grassland fauna such as Blackbuck that now live in small hyper-dense, isolated populations would also benefit if corridors could be developed between PAs. However, in this ecotype corridoring is less feasible, due to extensive agricultural tracts in the Deccan Plateau.

III. Biotic pressures and management patterns

Interactions between the biotic pressures and the past and present management practices of the PA produce a spectrum of changes on the naturally occurring landscape types. Thus 'natural' patterns may undergo varying degrees of degradation. Plantation especially of exotic species, undermines the 'naturalness' of the vegetation.

Protected Areas can have multiple uses. However this is frequently a carefully adjusted compromise. (Whitmore 1990).

The PAs and Resource Use

PAs have several tangible and intangible economic benefits. Some resources, such as, food, fuelwood and fodder, which are collected from the forest are easily quantifiable. This aspect has led to the establishment of what have come to be known as 'Extractive Reserves'. Other benefits, even if obvious, cannot be easily quantified in financial terms. For instance, the value ascribed to protecting soil and water is difficult to quantify. Forest PAs in hilly regions are more effective mechanisms for soil and water conservation than those in the plains.

In a forest system the most obviously quantifiable economic return is from timber; in a wetland, the economic potential of fish is most evident, while in a grassland, the biomass available as fodder form tangible economic indicators. However, since a PA is primarily intended to protect ' natural ecosystems', the uncontrolled use of these major resources would damage the conservation status of the PA. Such use may have to be restricted or in some cases prevented altogether. Resources must therefore be substituted through alternate means such as an ecodevelopment programme.

There is evidence to show that the timber value of a forest may in fact be less than the value obtained from Minor Forest Produce (MFP) that can be collected and sold on a sustainable basis. "Though this varies according to the site, it may well be as high as 75% if a detailed financial analysis is made". (Callish, Fight and Teeguarden 1978). The value of MFP is said to be 'higher than timber' and is more capable of being exploited sustainably (Peters, Gentry and Mendelson 1989). In many PAs, a sustainable amount of non wood products be collected without a major negative impact on its conservation values. This may add to the 'social value' of the PA which increases its local acceptability. Similarly, the value of harvestable resources such as fish from a wetland PA, which also gives protection to water fowl may be considerable (Bharucha and Gogate 1990). Fodder yields can be increased from grassland Protected Areas through good rangeland management. This could support both wildlife and a regulated number of livestock.

If natural resources such as fuel, fodder and MFP are used from PAs, it is important to quantify the extent to which this can be done without affecting its primary conservation objectives (Annexure II). Since the carrying capacity of the PA must consider the population of wild herbivores as well as a permissible number of cattle, it is essential to estimate their total fodder requirement. In most of our PAs the cattle outnumber wild herbivores.

If fuelwood and fodder collection is found to degrade a forest PA, it must be substituted from alternate sources. This is one of the major objectives of "ecodevelopment" for PA settlements. Buffer management must provide for these resources. A Participatory Rural Appraisal forms an objective basis to decide on how much land must be made available to develop such resources.

A tangible and easily quantifiable economic potential of PAs is through sustainable levels of wildlife tourism. Several authors have assessed the positive and negative impacts on conservation due to wildlife and ecotourism. (Phillips, Ademowicz and Boxall). The problem is that these financial benefits do not reach the 'local' people, who are adversely affected by the rise in prices of essential commodities around the PA. The revenue earned from tourism in the PA is not transferred to the PA for its better manage-ment for a variety of administrative reasons.

It is important to assess if tourism is causing a detrimental effect on the less robust habitats or threatened wild species. It is also essential to predict if it is likely to affect conservation values in future. Some PAs have very little tourism, due to the low accessibility of major glamour species, inadequate facilities, or a lack of available information about the PA. The ability of controlled tourism to enhance nature awareness among the public is a benefit to conservation itself. PAs can be considered an educational asset if an Interpretation Centre is developed. Managers of the PAs have stated that the number of visitors in different PAs is highly variable, most being day visitors. Koyna, Chandoli, and GIB had up to 5 thousand visitors per year, Andhari and Rehakuri between 5-10000 per year; Melghat and Radhanagari between 10-20 per year; S. Gandhi, Andhari, Pench, Yawal, Nagzira, Navegaon, Tadoba and Sagareshwar had over 20000 tourists per year. Most of the tourists are only casually interested in wildlife or use the PA as a holiday resort. Most PAs do not have an Interpretation Centre to orient them towards eco-tourism. Some tourists are attracted by the scenery, climate, or a venerated shrine.

IV. CONFLICT

The interaction between conservation goals and resource use leads to the "not in my backyard" phenomenon. This is the most contentious issue that confronts several PA managers. Compensation for loss of life or property damaged by wildlife is a major problem. An indication of the level of conflict in the form of cattle lifting by predators showed that Melghat had to pay a very high rate of compensation. Kalsubai, Chandoli and Bhimashankar also reported a large number of cattle kills. Attacks on humans were recorded from S. Gandhi and Nagzira. Serious crop damage was reported from Navegaon, Bhimashankar, GIB and Rehakuri; and moderate damage from Koyna, Radhanagari and Katepurna.

Crop damage due to Wildboar, Nilgai or Sambhar was reported from nearly every forest PA. Blackbuck was mainly responsible for crop damage in the GIB, Rehakuri and Katepurna Sanctuaries.

Impression

A scale to rate each of these PAs on the basis of its objectives and the three key parameters could help managers decide on conservation priorities for Maharashtra. This could also be used to modify and provide a pattern of management for the different PAs in the IPAS.

PART B

AN EVALUATION SCALE FOR GRADING PROTECTED AREAS

Among the most complex issues that must be considered while developing management plans for PAs are the difficulties in evaluating individual PAs and giving them relative ratings within the IPAS. This is however essential to allocate funds and manpower in a logical proportion for each PA.

The 'value' of biological diversity of an area must be assessed on parameters such as the level of biodiversity and its relative 'uniqueness'. At the species level, this includes the number of plant and animal species, the extent of endemism and the number of rare and threatened species. It must also take into account the systems level, i.e. the type and variety of landscapes, which represent various ecosystem types and the variety of plant and animal communities present in an intact form. Each landscape form is overlaid by the level of pressure on the 'natural' system due to which they display variable degradation forms. This results in a loss of their component species and an invasion of those that are colonizers in secondary vegetation. This is also related to the level of management which attempts to reverse or arrest deterioration. In some situations management may be incapable of mitigating existing levels of conflict between the people's needs and the conservation of biodiversity, resulting in a gradual degradation into less valuable biological communities. The number of species within an ecosystem can, however, be used as a fair indicator of the value of an area for prioritization in the IPAS, if ecosystem specificity is also given adequate weightage.

Though a variety of grading methods have been evolved by several authors, especially for Australia, USA and South America, they are not directly applicable to the scenario found in India. This paper presents a rating for the PAs of Maharashtra on a uniform evaluation scale based on a standardized scoring system. The system considers.

I) The objectives,
II) The key parameters, and
III) The potential values of PAs which include:
    A) The conservation potential;
    B) The utilitarian potential, and
    C) The conflict level resulting from interactions between protection and resource-use.

A similar grouping has been attempted by Wright (1977), on reviewing several grading schemes. It is suggested that there should be four groups of parameters that must be considered:

Group I : Scientific criteria (Biological and Physical characteristics);

Group II : Use values;

Group III : Degree of threat;

Group IV : Availability.

The above grouping has certain parallels with the grading scale evolved for Maharashtra.

Several authors caution that providing numerical scores should not disguise the use of subjective value judgments that were used for scoring. This is indeed a relevant argument. It is essential to describe clearly the subjective criteria on which the notional values have been ascribed. This paper provides a carefully specified set of criteria, as a safety measure against such a situation. Wright (1977) stresses the importance of including an appraisal of management in judging the conservation potential of an area. The data for their paper has been made on standardized cards similar to the questionnaires used to collect data in this paper.

Dony and Denholm (1985), stress the importance of a 'rarity' score. They state that the most popular criteria are diversity (richness), size, rarity, threat of human disturbance and naturalness, the first three being quantifiable. Their paper also differentiates species richness and diversity. The diversity values can be affected by variations in area, homogeneity or maturity. They claim that rare species are generally most vulnerable to human pressure and indicate unusual ecological conditions. In several 'tropical' and monsoonal forest systems the number of trees that account for 50% of the sample invariably include less than 10% of the species. Field studies in the Western Ghats being carried out by the present author shows that it is the rare species of trees that are progressively lost as intact forest systems are converted to degraded forests and finally into scrubland. However, all the sites which need to be protected may not have rare species and still need to be preserved in an IPAS Dony and Denholm (1985) also mention the problem of scale, i.e. rarity must be assessed at local, regional or national levels to be meaningfully used to develop management strategies.

The vegetation patterns of PAs can be classified into different ecosystems and different forest types Puri *et al.* 1983). The conservation status of a PA is a reflection of the various grades of biotic pressure of a variety of types that affect the ecosystem. Important parameters for judging its status are its biological values, such as the 'naturalness' of the vegetation and the presence or absence of 'glamour' wildlife species for tourism. Using these parameters, the conservation potential can be divided into four grades.

PAs must also support local people with resource-needs such as timber, fuel-wood, and fodder as well as support adequate tourist facilities. This aspect has been allotted four grades.

A third aspect is the grading of the level of 'conflict' between the needs of people and conservation goals, due to the proximity of the PA and its wildlife to human habitation.

These multiple factors and their interactions produce a variety of situations that affect the conservation of biodiversity in each of the PAs that constitute the IPAS (Ledec and Goodland 1988, McNeely 1988, Peters *et al*, 1989, Phillips *et al.*).

This grading scale has been established on the basis of 'notional values' that ascribe a relative score for each of these clearly discernible parameters in each PA. While some parameters are easily quantifiable, others are relatively intangible.

The scoring system forms a useful management tool. For example it can be argued that areas with higher than average conservation importance and higher levels of conflict should be provided more funds and more intensive management. On the other hand, if nothing is done to maintain PAs of a lower conservation status they will be degraded further, perhaps irretrievably. Adequately supported, these latter could become viable conservation sites. It would be, however, illogical to provide unnecessarily large funds for a PA of little conservation consequence, if high priority areas are left short of funds. An assessment based on the pattern evolved in this study, would help prioritize these issues.

The grading can also be used for selecting an appropriate strategy, from a set of broad management options, for each PA. This implies selecting a primary strategy from one of three management options - restoration, rehabilitation, and substitution of resources (Box 3). At times appropriate combinations of these in the form of primary and secondary management options may have to be used for different zones in the PA. The basic strategy may thus be supplemented by supportive measures in relation to the needs of the area. The management plan for the PAs must zone the area and the surrounding landscape types into different categories so that appropriate conservation actions can be initiated. This must take into account the utilization of the habitat by key wildlife and the conflict levels due to human activity. For example, Blackbuck (*Antilope cervicapra*) change their behavioural patterns in modified habitats. Elephants change their feeding behaviour in response to changes in the size of their habitat (Bharucha and Asher 1993).

This grading scale, using a selection of the most important and obvious parameters, is essentially aimed at formulating a model that can be extended to include a larger set of parameters based on detailed quantified field studies. It can also be used to select specific management strategies for individual PAs taking into account their relative status within the IPAS. The strategy would aim to develop an ecorestorative effort to bring about a high degree of 'naturalness'. It would also develop a parallel ecodevelopment plan to reduce biotic pressures on the PA (Gadgil 1987).

I. Rating PAs by their Objectives

The scoring system designed to rate an individual PA by its perceived objectives has been provided in (Table V).This has been used to evaluate each of the PAs and to provide a relative score.

Table V

NOTIONAL VALUES FOR RATINGS OF PA OBJECTIVES

Maximum value	Primary objective (4)	Secondary objective (3)	Tertiary objective (2)	Total (9)
Value of perceived objective				
Low grade	2	1	0	3
Moderate grade	3	2	1	6
High grade	4	3	2	9

Insert A : Specific Parameters

1	B	Preservation of high levels of Biodiversity (+ indicates highest estimated value)
2	E	Protection of Endangered species or Endemic fauna
3	P	Conservation of important Plant values
4	R	Preservation of Relict or threatened ecosystems
5	MUA	Multiple Use Area - fishing, fodder, etc.
6	S	Sustainable resource-use possibilities
7	L	Lake siltation prevention
8	W	Water regime protection from hill slopes
9	T	Used for Tourism: Over 20,000 per year - Primary objective 10,000 - 20,000 per year - Secondary objective 5,000 - 10,000 per year - Tertiary objective

TABLE VI
SPECIFIC OBJECTIVES

S. No.	Name	Primary		Secondary		Tertiary		Total Score
1	Radhanagari	B+ / P / E / R	4	W / L / (f-T)	2	Cr / Ex	2	8
2	Melghat	B / E / P / W	4	T / Ex	2	Cr / MUA	2	8
3	Tadoba	B / T / E	3	S / W / Ex	3	Cr / MUA	2	8
4	Bhimashankar	B+ / P / R / E	4	T / W	2	Cr / (f-S)	1	7
5	Nagzira	B / T / E	3	(f-S) L / R	2	Cr / Ex	2	7
6	Andhari	B / T / E	3	(f-S) / Cr / Ex	2	MUA / W	2	7
7	Navegaon	B / L / T	3	W / S / (f-Ex)	2	Cr / MUA	2	7
8	Koyna	B / L / P	3	T / W	2	(f-S)	0	5
9	Chandoli	B / R / P	3	E / T	2	(f-S)	0	5
10	Tansa	L / (f-T)	1	W / S / E	3	MUA	1	5
11	Sanjay Gandhi	L / T	2	(f-S) / W	1	Ex / Cr	2	5
12	Phansad	B+ / P / R	3	(f-T) / (f-Ex)	0	Cr / MUA	2	5
13	Chaprala	B / P / E / R	4	(f-T) / (f-Ex)	0	MUA	1	5
14	Pench	L / T / (f-S)	2	W / L	2	(f-Ex) / Cr	1	5
15	Painganga	B / E/ R	3	W / (f-T) / (f-S)	1	MUA	1	5
16	Malvan	E / R / P /(f-T)	3	MUA / (f-Ex) / (f-S)	1	Cr	1	5
17	Kalsubai	B / P / R	3	W	1	(f-T)	0	4
18	Karnala	T	1	Cr / W	2	Ex	1	4
19	Bor	B / (f-T) / E	2	S (f-Ex)	1	Cr	1	4
20	Aner Dam	W / R (f-T)	2	(f-S) / MUA / Cr	2	(f-Ex)	0	4
21	Gugamal	B / (f-S)	1	W / (f-T) / Cr	2	(f-Ex)	0	3
22	Gautala	B /P	2	(f-T) / (f-S)	0	MUA	1	3
23	Yawal	E / T	2	(f-S) / (f-Ex)	0	MUA	1	3
24	GIB	E	1	T	1	MUA	1	3
25	Jayakwadi	MUA / S	2	T / (Cr)	1	(f-Ex)	0	3
26	Nandur-Mad.	MUA / S	2	T / (Cr)	1	(f-Ex)	0	3
27	Sagareshwar	T	1	R	1	(f-Ex)	0	2
28	Katepurna	R / (f-T)	1	(f-S)	0	MUA	1	2
29	Rehakuri	E / R	1	T	1	(f-S)	0	2

10	Cr	Conservation research possibilities
11	Ex	*Ex - situ* Conservation possibilities
12	f	Future possibilities for 1 - 11**
*	G	General objectives of conservation (local, national and global concerns)

Insert B:

Primary objectives :
4 parameters = High grade
3 parameters = Moderate grade
2 parameters = Low grade

Secondary objectives :
3 parameters = High grade
2 parameters = Moderate grade
1 parameter = Low grade

Tertiary objectives :
2 parameters = High grade
1 parameter = Moderate grade
0 parameter = Low grade

****Note** : These parameters represent perceived objectives that can be laid down for these PAs. Most of these are either being implemented or are being attempted. Those that can also be attempted by broadening the scope of the PAs objectives have been put into brackets and not used for the rating.

RATING ON THE BASIS OF PRIMARY, SECONDARY, AND TERTIARY OBJECTIVES

For an easily manageable scoring system, the primary objectives are limited to a maximum of four, secondary objectives to three and tertiary to two. Accordingly the relative scoring by the number of primary, secondary and tertiary objectives can be used to provide a grade and an index of the PAs rating by objectives (Table V).

The ‘objectives’ of an established PA play a major role in influencing its evaluation. The aim of rational land use planning includes PAs as a vital component primarily to conserve biodiversity, and secondarily to sustainably manage renewable resources for the region. If a PA has a high probability of achieving several of these goals it is given a higher rating (Table VI). A lower rating is ascribed if it has only a few parameters. This is a reflection that the PA has a disturbed ecosystem or supports only a few species in an unnatural habitat. Areas such as Rehakuri, GIB Sanctuary, Sagreshwar and the man-made wetland PAs of Nandur and Jayakwadi thus have lower ratings based on objectives.

Grading for four important primary objectives gives a PA a greater value. Secondary or tertiary objectives, such as to provide economic benefits for surrounding people, or the availability of resources for human use, or its tourist potential, or the ability to enhance global environmental conditions, have been given a relatively lower importance. Each parameter has been separately evaluated and included to rate the PA's utilitarian functions at local or global levels.

Based on their perceived objectives, PAs such as Radhanagari, Melghat and Tadoba have the highest ratings. This group of very important PAs is followed by Bhimashankar, Nagzira, Andhari and Navegaon. PAs such as Koyna, Chandoli, Tansa, Sanjay Gandhi, Phansad, Chaprala, Pench, Painganga and Malvan are of the moderate group, while the rest are rated low for their objectives. Certain parameters are relatively fixed due to a PAs location, ecosystem type, size, etc. This can be said to give it a biogeographically fixed rating.

II. RATING PAs ON KEY PARAMETERS

BIOGEOGRAPHICAL RATING

On the basis of biogeographical criteria PAs can be provided with a baseline rating in the IPAS, as follows :

(A) According to the proportion of land in PAs in different biotic provinces;
(B) The representation in different ecosystems; and
(C) Their relative sizes.

This is used to define their individual biogeographical rating in the network. These values are not affected by the level of management inputs and are thus relatively fixed.

A. The representation of the biotic provinces within the IPAS is used to provide a notional value of 3 for the areas where the representation is below the requirement of the IPAS, a lower value of 2 for those which have adequate representation and 1 for those that are over represented. This has been established in Table III and included in Table VIII (Column A).

B. The representation of different ecosystems in the 29 PAs is shown in Table III (Puri *et al.* 1983 p. 285). The number of PAs that protect different ecosystems is given in Table VII. The poorly represented ecosystems are given a higher notional value. These should be intensively protected. If the ecosystem is represented in less than 5 PAs the notional value given is 3; between 6 and 10 PAs, the value is 2; and in 11 or more, a value of 1. This score has been used to assess the rating for each PA (Table VII, Column B).

TABLE VII
NUMBER OF PAs THAT PROTECT DIFFERENT ECOSYSTEMS

Ecosystems	No. of PAs (A)	Notional Value (B)
Forest PAs		
Evergreen	3	3
Semi-evergreen	10	2
Moist deciduous	14	1
Dry deciduous	11	1
Thorn forest	1	3
Non-Forest PAs		
Grass and Scrubland	4	3
Wetlands	2	3
Marine	1	3

Note:- The total is over 29 as more than one system is represented in several PAs.

C. The relative importance in relation to size is shown in Table IV. The three categories are rated as follows:

Category I - Over 250 sq. km has a rating of 3;
Category II - 100 to 250 sq. km has a rating of 2;

TABLE VIII

BIOGEOGRAPHICAL RATING

	PAs	A +	B +	C =	D	E
1	Radhanagari	2	3	3	8	3
2	Kalsubai	2	3	3	8	3
3	Bhimashankar	2	3	2	7	2
4	Koyna	2	2	3	7	2
5	Chandoli	2	2	3	7	2
6	Tansa	2	2	3	7	2
7	S. Gandhi	2	2	1	5	2
8	Karnala	2	2	1	5	2
9	Phansad	2	2	1	5	2
10	Chaprala	2	2	2	6	2
11	Melghat	1	1	3	5	2
12	Gugamal	1	1	3	5	2
13	Pench	1	1	3	5	2
14	Nagzira	1	1	2	4	1
15	Andhari	1	1	3	5	2
16	Painganga	1	1	3	5	2
17	Gautala	1	1	3	5	2
18	Yawal	1	1	2	4	1
19	Navegaon	1	1	2	4	1
20	Tadoba	1	1	2	4	1
21	Bor	1	1	1	3	1
22	Sagreshwar	3	3	1	7	2
23	GIB*	1	1	1	3	1
24	Aner	1	1	1	3	1
25	Katepurna	3	3	1	7	2
26	Rehakuri	3	3	1	7	2
27	Jayakwadi	2	3	1	6	2
28	Nandur	2	3	1	6	2
29	Malvan	3	3	1	7	2

A - Representation requirement in biotic province; **B** - Ecosystem representation; **C** - Size; **D** - Total; **E** - Average (to nearest whole number).

Higher values are given if Biotic province or ecosystem is relatively under represented.

* This rating considers the fact that most of the area is largely agricultural.

Category III - less than 100 sq. km with a rating of 1.

This is in accordance with the norms required for staffing of PAs laid down by the Government of India. However, these Categories could be further divided into IA, above 1000 sq. km. Category IB, 500 to 1000 sq. km, Category IIIA, 25 to 100 sq. km and IIIB - 1 to 25 sq. km. These subdivisions are essential for rating Protected Areas in relation to size. The values given for each PA for rating by size is given in Table VIII, Column C.

D. These 3 quantifiable values have been aggregated to rate the basic biogeographical value of each PA within the IPAS in Table VIII, Column D. The average rating for Conservation Potential for these three parameters has been rounded off to the nearest unit for each PA and is given in Table VIII, Column E.

Scoring criteria for three key issues based on specific parameters and management inputs

Assessing the degree to which each PA has achieved its objectives is difficult to quantify. An estimate in terms of its perceived objectives as against partially achieved or satisfactorily achieved targets is however possible. The success or failure of management requires a much greater degree of quantification and must be repeated periodically and as such has been only attempted here, during a brief period of three years. However, it has temporal implications over a much longer duration. It is possible that with good management these perceived objectives of a PA could be partially or eventually totally achieved, thus improving a PAs relative rating in the IPAS. If however, there is a progressive escalation of pressures, or poor management, the rating may be brought down on the evaluation scale.

The evaluation of the conservation and utilization potentials, as well as local conflict levels, in each PA, was strengthened by providing a score for these parameters under the three major heads as follows:

Protected Areas could have objectives that give them a conservation potential that ranges from a high to a low rating in the IPAS. A Protected Area could have few management problems, or have serious difficulties for its adequate management which could jeopardize its conservation status. Thus each PA may be placed in a matrix depending on the importance of its objectives and the level of management problems (See Box 2).

A matrix of possible combinations of parameters based on objectives and management problems which operate in a PA is shown in Table IX. It is evident that the preliminary scoring on objectives alone is inadequate for an objective

Box 2

Objectives	Low Level of Management Problems	Serious Management Problems
Highly rated PA	Continue existing Management	Improve management. Increase Resources. Increase Manpower.
Poorly rated PA	Continue existing Management	Lower objectives (or) Redesign (or), write off as a PA.

evaluation of a PA within the IPAS. Though the grading should be related to the relative importance of the objectives of a PA, its potential to achieve these goals is related to three key issues : (a) Conservation Potential; (b) Utilitarian Potential; and (c) Level of Conflict.

a) A large number of factors that cannot be easily quantified, must be considered for evaluating its Conservation Potential, such as its overall biological importance in terms of fragility and rarity of the ecosystem, the level of species richness and the presence of endangered or endemic animals and plants. Another factor that must be considered is the 'naturalness' of the ecosystem. Undisturbed natural forest must be rated higher than plantations. Fragmented or degraded PAs or those with high disturbance levels are given relatively lower ratings. Grasslands with a large number of grass species would be rated higher than those with high levels of pressure and few species in the ground cover.

b) The other factor for evaluating a PA is related to its ability to sustain human life. Their functions such as retaining soil, maintaining moisture regimes and providing for the daily needs of local people must be taken into account to grade the PAs. This needs a separate evaluation.

c) Finally, the interaction between the needs of conservation and the use of the area and its resources leads to different levels of conflict. The degree of these conflicts is related to the long term survival of the PA.

The guidelines used to give a score for these three key issues is given in Table IX. Using these graded criteria each PA has been given a score for Conservation, Utilization and Conflict Level, Table X. These values are reflected in Table XI for individual PAs.

III. Potential of PAs for Conservation, Utilization and the Conflict Level.

a) Conservation Potential: The conservation potential i.e. the Biological importance, 'naturalness' of vegetation and major wildlife values are given four grades, with values of 0 to 3, for each parameter (Table IX).

In the Conservation Potential a high rating is given to biological values such as the uniqueness of the ecosystem (Table III); the relative size of the PA (Table IV). The score in terms of biological value is reduced if similar ecotypes have been protected in other PAs (Table VII). An estimate of generally known species diversity; the presence of endangered species; and optimal habitat conditions to maintain wildlife populations provides a fair degree of the level of importance of a PA (Table XIa). The parameters used are thus Biogeographic importance, Naturalness of vegetation, Wildlife values which together provide a score from 0 to 9. The value is progressively reduced if the area is fragmented by other land-use patterns such as agriculture, plantations, etc.

b) Utilitarian Potential: The level of utilization of resources and the ecodevelopment possibilities in terms of providing timber, fuelwood, fodder and MFP as well as tourist facilities are given 4 grades (Table IXb). This provides scoring values of 0 to 3 for each parameter (Table Xb).

The values are influenced by the number of settlements within and on the borders of the PA and the pressure due to human and cattle populations. It also takes into account the existing management and the presence of interested Forest Department personnel and active NGOs who can collaborate in an ecodevelopment program.

TABLE IX

SCORING "VALUES" FOR ASSESSMENT OF THE POTENTIAL GOALS OF CONSERVATION/UTILIZATION/ CONFLICT LEVELS

"Values"	Grade I	Grade II	Grade III	Grade IV	Total
a) Conservation Potential - Biological Value					
Biogeographical Importance	Very important	Moderately important	Not significant	Biologically worthless	
Summation of Biotic ecosystem representation and size. (See Table VIII)	Distinctive ecosystem	Fragmented + ecosystem	Similar areas protected (Fragmented ++)	Totally degraded	
	Large size	Moderate size	Small size	Highly disturbed	
Plant values Habitat	Climax system	Marginally disturbed	Plantations Secondary	Highly disturbed	
	Optimum habitat for wildlife	Still very desirable for wildlife	Growth, sub-optimal habitat for wildlife	Intense human pressure	
	Very High Endemism and/or 'Naturalness'	Adequate Endemism and/or 'Naturalness'	Low Endemism and/or 'Naturalness'	Poor Endemism and/or 'Naturalness'	
Wildlife Values	High diversity Balanced population of prey and predator.	Highly man-managed to maintain balance. Signs of over abundance of wildlife.	Under-populated in relation to habitat. Requires better management.	Poor or absent. Severe people wildlife conflict	
	Endangered species ++	Important species +	Less important species	No important species	
	Increasing trend	Stable trend	Falling trend	Irreversible trend	
Score	Maximum	>	>	Minimum	X
b) Utilitarian Potential					
Timber	Exploitable areas present without degradation	Moderate potential due to past exploitation	Over exploited	Severely degraded No timber value	

Table IX contd.

"Values"	Grade I	Grade II	Grade III	Grade IV	Total
Food, Fodder, Fuel, marketable MFP	Exploitable without degradation	Exploitable with control and ecodevelopment input	Over exploited. needs large ecodevelopment input	Totally degraded	
Other Values					
Tourism	Correctly utilized	Underutilized	Overutilized	Adversely affects area.	
Hydro					
Catchment protection	Very important function	Moderately important function	Small function	No function	
Score	Maximum	>	>	Minimum	Y
c) Conflict level with proposed objectives	Minimal	Moderate	Severe	Very Severe	Score
Score:	Maximum	>	>	Minimum	Z

* Grade I provides the maximum 'value' while grade IV the minimum. An area would be graded in the format Conservation = X, Utilization = Y, Conflict level = Z.

The 'values' can be compared with other areas to place an area as: Highly desirable for conservation, significant, insignificant, or worthless.

TABLE X

SCORE VALUES FOR GRADES IN EACH PARAMETER

Scoring pattern	Grade I	Grade II	Grade III	Grade IV
a) Consevation potential				
1) Biogeographical importance	3	2	1	0
2) Plant or habitat values	3	2	1	0
3) Wildlife values	3	2	1	0
Total	9	6	3	0
b) Utilitarian potential	Grade I	Grade II	Grade III	Grade IV
1) Timber	3	2	1	0
2) Fuel, fodder & food	3	2	1	0
3) Other values-Tourism/ Catchment, etc.	3	2	1	0
Total	9	6	3	0
c) Conflict Level with proposed objectives	9	6	3	0

Note : For Conflict levels the highest score is 9 for Grade I which indicates minimal conflict, and lowest is 0 for Grade IV indicating maximal conflict.

The utilitarian potential is an indicator of the financial and infrastructural input that would be required for site specific ecodevelopment schemes that may help conserve biodiversity (McNeely 1988, p. 57). Baseline data on land and resource-use parameters were obtained from PA managers and through site visits (Annexure I, II). These are used for scoring Utilitarian Potential for each PA. A close interaction with local people to identify these baseline parameters is essential for evaluating the ecodevelopment potential of each PA. A Participatory Rural Appraisal is an essential interactive process before implementation of an ecodevelopment program. The human and cattle population density per hectare in a PA has been used as one index of the level of biotic pressure. Overall notional value for Utilitarian potential ranging from 0 to 9 is given for the PAs, (this data provided by PA managers provides an index of local management problems). The high pressure PAs with a human population of over 0.5 per hectare were given values as follows: Painganga - 1, Gautala - 1, GIB - 2 and Nandur - 5. Between 0.1 to 0.5 per hectare the values

Table XI
SCORING STATUS OF 29 PAs

Name of PA	(a) Conservation potential				(b) Utilitarian potential				(c) Conflict
	Biogeo. imp.	Nat. veg.	Wild. value	Total Score	Timber	Fuel, fodder, food	Tourism	Total Score	Score
Andhari	2	2	1	5	2	2	2	6	6
Aner Dam	1	1	2	4	1	1	1	3	5
Bhimashankar	2	3	2	7	2	1	1	4	3
Bor	1	2	1	4	1	1	1	3	5
Chandoli	2	3	1	6	2	1	1	4	4
Chaprala	2	2	2	6	1	1	1	3	3
Gautala	2	1	0	3	0	0	1	1	3
GIB*	1	0	1	2	0	0	2	2	1
Gugamal	2	1	2	5	2	1	2	5	5
Jayakwadi	2	1	1	4	1	1	2	4	2
Kalsubai	3	1	0	4	1	1	1	3	4
Karnala	2	1	0	3	1	1	1	3	4
Katepurna	2	1	0	3	0	1	1	2	3
Koyna	2	3	1	6	1	2	2	5	6
Malvan	2	2	3	7	1	1	2	4	3
Melghat	2	2	3	7	2	2	3	7	6
Nagzira	1	3	3	7	2	2	1	5	6
Nandur Mad.	2	1	1	4	1	1	3	5	2
Navegaon	1	3	2	6	2	2	1	5	3
Painganga	2	1	1	4	0	0	1	1	3
Pench	2	2	1	5	2	2	1	5	3
Phansad	2	3	1	6	1	2	2	5	6
Radhanagari	3	3	3	9	2	2	3	7	6
Rehakuri	2	0	1	3	1	1	1	3	1
S. Gandhi	2	2	1	5	2	2	1	5	3
Sagareshwar	2	0	0	2	0	0	2	2	3
Tadoba	1	3	3	7	2	2	1	5	9
Tansa	2	2	1	5	2	2	3	7	3
Yawal	1	1	0	2	1	1	1	3	5

Note:- Biogeo. imp.- Biogeographical importance Nat. veg.- Naturalness of vegetation; Wild. val.- Wildlife values; S.Gandhi - Sanjay Gandhi; Nandur Mad.- Nandur Madhmeshwar.

given were: Yawal - 3, Bhimashankar - 4, Aner - 3. PAs with less than 0.1 per hectare were given the following values: Melghat - 7, Andhari - 6, Pench - 5, Nagzira - 5, Navegaon - 5, S.Gandhi - 5 and Katepurna - 2. In several PAs precise figures were not available and population pressure was estimated by questioning people or by looking at PA maps and the number of settlements.

In response to questionnaires, PA managers also opined on the feasibility of establishing ecodevelopment programs. Some indicate a paucity of funds or expertise. The ability to produce adequate quantities of fuel and fodder is at best a guestimate and is related to factors such as the availability of land to develop the resource and the willingness of people to participate in joint management of PA resources.

It is obvious that in a PA only a very limited amount of timber extraction can be done so this must essentially provide an overall low rating. If a similar rating were to be used for a non-PA situation this would become an important index. Cattle grazing

Table XII

RANKING FOR DIFFERENT PA POTENTIALS

(a) Conservation Potential		(b) Utlitarian Potential		(c) Conflict level		Overall score		Rank (A)	Rank (B)
Radhanagari	9	Melghat	7	Tadoba	9	Radhanagari	22	1	1
Tadoba	7	Radhanagari	7	Melghat	6	Tadoba	21	2	3
Nagzira	7	Tansa	7	Andhari	6	Melghat	20	3	2
B'shankar	7	Andhari	6	Nagzira	6	Nagzira	18	4	5
Malwan	7	Gugamal	5	Koyna	6	Andhari	17	5	6
Melghat	7	Tadoba	5	Radhanagari	6	Koyna	17	6	8
Navegaon	6	Pench	5	Phansad	6	Phansad	17	7	12
Chaprala	6	Nagzira	5	Gugamal	5	Gugamal	15	8	21
Koyna	6	Navegaon	5	Yawal	5	Tansa	15	9	10
Phansad	6	Koyna	5	Aner Dam	5	Malwan	14	10	16
Chandoli	6	S. Gandhi	5	Bor	5	Navegaon	14	11	7
Gugamal	5	Phansad	5	Kalsubai	4	B'shankar	14	12	4
Andhari	5	Nandur	5	Chandoli	4	Chandoli	14	13	9
Pench	5	B'shankar	4	Karnala	4	Pench	13	14	14
Tansa	5	Chandoli	4	Painganga	3	S. Gandhi	13	15	11
S. Gandhi	5	Jayakwadi	4	Gautala	3	Bor	12	16	19
Jayakwadi	4	Malwan	4	Pench	3	Aner Dam	12	17	20
Aner Dam	4	Yawal	3	Navegaon	3	Chaprala	12	18	13
Bor	4	Aner Dam	3	B'shankar	3	Kalsubai	11	19	17
Painganga	4	Bor	3	Tansa	3	Nandur Mad.	11	20	26
Kalsubai	4	Kalsubai	3	S. Gandhi	3	Yawal	10	21	23
Nandur	4	Karnala	3	Chaprala	3	Jayakwadi	10	22	25
Rehakuri	3	Chaprala	3	Sagreshwar	3	Karnala	8	25	28
Gautala	3	Rehakuri	3	Katepurna	3	Painganga	8	24	15
Karnala	3	Sagreshwar	2	Malwan	3	Katepurna	8	25	28
Katepurna	3	GIB	2	Jayakwadi	2	Gautala	7	26	22
GIB	2	Katepurna	2	Nandur	2	Sagareshwar	7	27	27
Yawal	2	Painganga	1	Rehakuri	1	Rehakuri	7	28	29
Sagreshwar	2	Gautala	1	GIB	1	GIB	5	29	24
Median	5		4		4				

Note:- Rank (A) - Rank Achieved; Rank (B) - Rank on Perceived Objective (Table VI).
S. Gandhi - Sanjay Gandhi National Park; Nandur - Nandur Madhmeshwar; GIB - Great Indian Bustard Sanctuary; B'shankar - Bhimashankar.

also has a negative impact in most of the PAs. The sustainable collection of MFP is given a higher rating as it may not affect the PA adversely. Sustainable ecotourism is a potential source of income for local people and is thus included in the utilization aspect of the PA functions. The Utilitarian Potential with scoring for the 3 utilitarian parameters is given in Table XIB.

c) Conflict levels : The level of conflict between conservation goals and peoples' resource needs are given four grades. The minimum conflict level is given the highest rating and serious conflict the lowest.

Conflict levels are the most difficult to rate in the absence of detailed impact studies of the PA on the lifestyles of local people. Crop damage, cattle lifting, man kills, restrictions on the use of natural resources, access to markets, transport, water, etc. have been taken into account from the PA managers' responses to questionnaires. However, this would need detailed PRAs for increasing the accuracy of evaluations. It may be noted that in the absence of a detailed PRA of all the settlements in and around a PA, ratings can be biased.

Each of the PAs have been given scores for different parameters (Table XI). Though it can be argued that the value selected in a certain parameter is subjective, this does not detract from its ability to help provide a comparison between different Protected Areas. It has been stated that " Quantifying conservation values is a complex and often subjective assessment" (Smith 1990). However a PRA can help to reduce the bias by conversing with a large number of people, both from the management personnel as well as local people and NGOs.

Note : The biogeographic ratings for PAs are given out of a total of 9 (Table VIII). This is averaged to the nearest whole number as the scores for biogeographical importance and included in Table XI which is rated from 0 to 3. The biological importance not only takes into account the biogeographical rating but considers a variety of other factors. These are 'distinctiveness' of the ecosystem; guestimates of the level of biodiversity and the known number of endemic or endangered species. The utilitarian values are also built up through a variety of separately quantifiable values to develop an overall score for each PA. The Conflict Levels are a reflection of the interaction between the management established for a PA and the needs of local people. All three have been aggregated into an overall score in Table XII.

Table XI shows the values given in each parameter to the PAs, and the score for their Conservation Potential, Utilization Potential and Conflict Levels. Whereas some PAs have better aggregate scores for their conservation potential others have greater utilitarian value with the ability to support people through ecodevelopment programs. Still others have lower levels of conflict with proportionately higher ratings in this vital component.

Table XII shows the rating for each aspect of a PA's function in order of merit. This shows that ranking varies considerably in each data set. The median value for conservation potential is 5, for utilitarian potential 4, and for conflict level 5.

For example - the highest ratings for the Conservation Potential is for Radhanagari - 9; Tadoba -7; Nagzira - 7 and Malwan -7. In terms of their ability to support their Utilitarian Potential for different functions and an ecodevelopment program the highest scores are found in Melghat - 7; Radhanagari - 7; and Tansa - 7. The Conflict Level is minimum in Tadoba - 9; as there are no settlements within its boundaries.

Adding these together to provide a total overall score for the status of the PAs shows that Radhanagari has 22, and Tadoba - 21; followed by Melghat - 20; and Nagzira - 18. This however gives little indication of the status of a PA. Aggregating the individual scores of Conservation, Utilization and Conflict Levels do not give a clear picture of the different aspects necessary to evaluate the success level achieved for a specific PA in the IPAS.

An unusually low scoring is ascribed to the GIB sanctuary with a Conservation Potential score of 2, a Wilderness Utilization Potential of 2, and its Conflict Level with a score of 1. The overall score is 5 showing that though this PA is created for the highly endangered Great Indian Bustard, in its present form it is not of much significance. If however, the rating of only Nanaj and a few other pockets having this endangered bird is considered , i.e. 400 sq. km out of the present 8,496 sq. km, the rating would be different. The Conservation Potential would be 6, the Utilization Potential 6 and the Conflict Level 6, i.e. an overall aggregate score of 18. This would place it among the more valued PAs. The example of the GIB sanctuary illustrates how scoring on a conservation evaluation scale can influence management of PAs and help redefine boundaries if necessary.

An important observation is the change in the rating of individual PAs observed in Table V, which provides a score for perceived objectives and that actually achieved in Table XII. The shift can be related to a variety of issues due to which perceived objectives of the Bhimashanker Sanctuary gave it a

Table XIII
SCORES OF CONSERVATION, UTILISATION AND CONFLICT LEVELS AND PA SIGNATURES

	Name of PA	Conservation level (A)	Utilitarian level (B)	Conflict level (C)	Signatures ** A	B	C
1	Radhanagari	9	7	6	+	+	+
2	Melghat	7	7	5	+	+	+
3	Tadoba	7	5	9	+	+	+
4	Koyna	6	5	5	+	+	+
5	Phansad	6	5	5	+	+	+
6	Nagzira	7	5	5	+	+	+
7	Andhari	5	6	6	0	+	+
8	Gugamal	5	5	5	0	+	+
9	Navegaon	6	5	2	+	+	-
10	Chandoli	6	4	4	+	0	0
11	Bhimashankar	7	4	3	+	0	-
12	Malwan	7	4	3	+	0	-
13	Pench	5	5	3	0	+	-
14	Tansa	5	7	3	0	+	-
15	S. Gandhi	5	5	2	0	+	-
16	Chaprala	6	3	3	+	-	-
17	Nandur Mad.	4	5	2	-	+	-
18	Jayakwadi	4	4	2	-	0	-
19	Bor	4	3	4	-	-	0
20	Aner Dam	4	3	4	-	-	0
21	Yawal	2	3	3	-	-	0
22	Kalsubai	4	3	4	-	-	0
23	Karnala	3	3	4	-	-	0
24	Katepurna	3	2	4	-	-	0
25	Painganga	4	1	3	-	-	-
26	Gautala	3	1	3	-	-	-
27	Sagareshwar	2	2	3	-	-	-
28	Rehakuri	3	2	1	-	-	-
29	GIB	2	2	1	-	-	-

Note: +: Above median, 0: Median, -: Below median.
** Low conflict levels have high notional values. High conflict levels have low notional values.

rating as the 4th in the IPAS. However the aggregated score for conservation, utilization and the conflict level patented gives it the 4th rank (Table XII, column A), it falls to 14th and 19th place in the Utilitarian Potential and the high conflict level. Thus the perceived objectives appear to be biased by its high biological value. The disparity between perceived objectives (Table V) and the achieved ranking (Table XII) can be evaluated for each PA in Table XII.

Overall Score and Individual Rating

Table XII shows that the PAs can be divided into 3 major groups. Those having scores for conservation, utilization and conflict levels above the median value, those of a median value and those that have ratings below the median value.

In Table XIII, those with a score above the median value are given a '+' sign, the median value is given a '0' sign, while those below the median value are given '-' sign, for each data set. Accordingly, the combinations possible are 3^3 and a PA could have one of 27 different combinations (Table XIV, Column A). Of these the PAs fall into 11 categories, i.e., the existing signatures (Table XIV, Column B).

Thus each PA has its own 'Signature' depending on its relative status in the IPAS. This

Table XIV
SIGNATURE OF PAs IN THREE GROUPS

(A)	(B)	Signature	PAs
		Group I: 7 PAs	
1	1	(+++)	Radhanagari, Melghat, Tadoba, Koyna, Phansad and Nagzira
2		(++0)	
3		(+0+)	
4	2	(0++)	Andhari, Gugamal
5	3	(++-)	Navegaon
6		(+-+)	
7		(-++)	
		Group II: 5 PAs	
8	4	(+00)	Chandoli
9		(0+0)	
10		(00+)	
11	5	(+0-)	Bhimashankar, Malwan
12		(+-0)	
13		(0+-)	
14		(000)	
15		(0-+)	
16		(-+0)	
17		(-0+)	
18	6	(00-)	Pench, Tansa, S. Gandhi
19		(0-0)	
20		(-00)	
		Group III: 17 PAs	
21	7	(+--)	Chaprala
22	8	((-+-)	Nandur Mad.
23		(--+)	
24		(0--)	
25	9	(-0-)	Jayakwadi
26	10	(--0)	Bor, Aner, Yawal, Kalsubai, Karnala, Katepurna
27	11	(---)	Painganga, Gautala, Sagreshwar, Rehakuri, GIB.

* (A) - Possible Signatures
(B) - Existing Signatures

method of rating can be used to indicate the best management options for individual PAs, and is a better indicator for selecting management options than the overall score. Table XIV shows the 'signatures' of each PA.

In the 3^3 , i.e. of 27 possible combinations that form a 'signature', there are three major groups:

Group I has either 3(+); or combinations of 2(+), with 1(0); or 2(+) with 1(-);

Group II has combinations of 1(+), with either 2(0); or 1(+), with 1(0) and 1(-); or 3(0)s.

Group III has combinations of 2(-) with 1(+) or 1(0), and 3(-)s (Table XIV).

Thus there are 8 PAs in Group I; 8 in Group II; and 13 in Group III. This gives a clear indication of the status of the PAs within the IPAS.

INTERPRETATION

(a) Conservation Potential

In the signature, a (0) for conservation would indicate an average placement in the IPAS. If a (+) sign is given for conservation this would necessitate a policy towards establishing an area with the highest level of protection and to 'restore' it to a level of being considered as a 'Strict Nature Reserve' by IUCN standards. A (-) sign would indicate a low conservation status. Here hard decisions must be made, as it may become essential to write off some of the least significant areas. No large financial outlays should be made for such areas under normal conditions. An exception would be the presence of an endangered species not found elsewhere, or some other specific objective that the PA is intended to protect or preserve.

(b) Utilitarian Potential

If for utilization a (0) is ascribed, these PAs would require an average outlay of the budget towards ecodevelopment which could be expected to maintain the ecosystem in its present state. A (+) sign indicates that pressures are low and if the financial input is adequate one can expect an improvement in the state of the ecosystem. Here the management must aim towards balancing conservation and utilization to provide a "rehabilitation" program to achieve a desired level of 'naturalness'. A (-) sign for utilization indicates a high resource pressure. Here the major thrust should be to "substitute" resources developed in external buffers. This also may need high economic support if the conservation potential shows a (+) sign. Several of these areas, however, may have to be managed as "Multiple Use Areas" as defined by IUCN.

(c) Conflict Levels

Finally, if the conflict sign is (0,) this is indicative of the average level of man-animal conflict, or between the needs of conservation of biodiversity, with natural resource use by local people in the PA. A (+) sign indicates lower than average levels and signifies good long-term possibilities for conservation. These are the areas where the local acceptance of the PA is likely to be most easily achieved. A (-) indicates a serious issue that would require a larger financial outlay towards compensating for losses (due to crop damage, cattle lifting, etc.). A major thrust of management in this situation must aim at reducing the conflict both within and on PA boundaries.

The 'Signature' and Management Issues

The signature is an aid for selecting management options and designing management plans for PAs. Of the 27 options available, the PAs fall into 11 patterns. These form three distinct groups see Table XIV. The issues that are to be taken into account relate to the preservation of biodiversity at species and landscape level and their relationship to specific local factors (Box 5).

1. (+++): Of the 29 PAs six have a (+++) signature (ie. 20.69%). The signature pattern (+++) indicates above average scoring for all three major criteria. In this group the possibility of restoration appears most feasible. The aim of management should be to create as large a core as possible with ecodevelopment inputs for conserving the buffer on a sustainable basis. The low conflict level is a distinct advantage, making restoration an attainable target. This strategy must thus be used to evolve management plans for Radhanagari, Melghat, Tadoba, Koyna, Phansad and Nagzira. Tadoba is the only National Park in this group. Thus Radhanagari, Melghat, Koyna, Phansad and Nagzira Wildlife Sanctuaries should be upgraded to NP status, to provide inviolate cores and better management. This would ensure their preservation on a long term basis. Melghat is of great conservation significance due to its large size, especially as tigers need large areas.

2. (0++): There are two PAs in this group (6.9%). The (0++) signature is given for PAs that may not have a very large conservation significance. However, with their relatively good ecodevelopment potential and low conflict levels, they may retain their present conservation status. These are Andhari and Gugamal.

3. (++-): In the 29 PAs only one had this signature (3.4%). In the signature pattern of (++-) though the conservation and utilization potentials are above average, the high conflict level may make restoration an unattainable and unpopular goal. Here the individual cause of conflict in each case would have to be addressed as a primary concern of management planning. Navegaon has a Naxalite problem with an otherwise high potential for long-term conservation.

4. (+00): Chandoli is the only PA in this group. This PA has a high conservation potential with average ecodevelopment possibilities and moderate levels of conflict. Chandoli in the Western Ghats is an important ecotype.

5. (+0-): This category has two PAs (6.9%). Malwan has a great conservation significance, being the only marine PA (3.4%). However, conflict with local fishing rights is a major issue. Bhimashankar has a very high biological significance as it is situated in a 'hot spot' of biodiversity. Local conflict issues which have been triggered off by local politically active NGO groups is a significant conflict triggering factor. This appears to have escalated problems instead of eliciting cooperative joint PA management with local people.

6. (0+-): There are three PAs in this group (10.3%). A (0+-) signature signifies a PA of average importance where ecodevelopment is feasible but conflict levels are unduly high. The management must thus focus on primarily reducing conflict. S. Gandhi NP is a problem PA due to the leopards which have been known to attack people living in the nearby slum.

7. (+--): This group has only one PA (3.4%). In the (+--) group Chaprala, though of considerable conservation significance has problems both due to human activity and resource pressure, as well as serious conflict. Management must thus attempt to preserve its high conservation value by providing alternate resources through ecodevelopment and minimizing conflict.

8. (-+-): In the 29 PAs 1 (3.4%) is in this group. The signature (-+-) indicates that the conservation potential is below average, the utilitarian potential is high and conflict is a serious issue. Here, restoration would in fact be unnecessary and may require inordinately high inputs if it were to be attempted. A more objective rehabilitation program might be a better management option. Nandur could thus form an ideal MUA as recommended for the proposed PA at Ujjaini (Bharucha and Gogate 1990).

9. (-0-): There is only one PA in this group (3.4%). Jayakwadi is a man-modified wetland system of low conservation value as a landscape type, however, it supports a large number of wildfowl.

10. (--0): There are six PAs in this group (20.69%). Those PAs which have a signature (--0) have a low conservation potential with low utilization potential and moderate levels of conflict. Management planning must focus on a good substitution program for resources and identify those that have specific conservation objectives. Bor, Aner, Yawal, Kalsubai, Katepurna and Karnala are included in this group.

11. (---): This group has 5 PAs (17.24%). The signature (---) has low conservation as well as utilization potentials and serious conflict levels. Included in this group are Painganga, Gautala, Sagreshwar, Rehakuri and GIB. These are problem areas which would require rehabilitation and a large substitution complement. The high conflict level would probably negate all efforts at conservation unless rapidly defused. These PAs require careful management if they are to play any role in the conservation of biodiversity in the State. Some may require a modification of their size, or a re-demarcation of boundaries. In others, serious people - wildlife issues may have to be solved. At present most of these can at best be looked upon as MUAs. The GIB Sanctuary is too large to manage and is primarily not a wilderness area and thus cannot be rehabilitated or restored. Rehakuri is too small for long-term viability, especially due to serious conflict due to crop damage by Blackbuck. Sagreshwar, though in a forest type not found in any other PA in Maharashtra, is of little conservation significance. In future some of the PAs in this group may have to be redesigned or their objectives lowered, so that their proposed objectives can be achieved.

IMPLICATIONS OF SCORING ON MANAGEMENT OF PAs

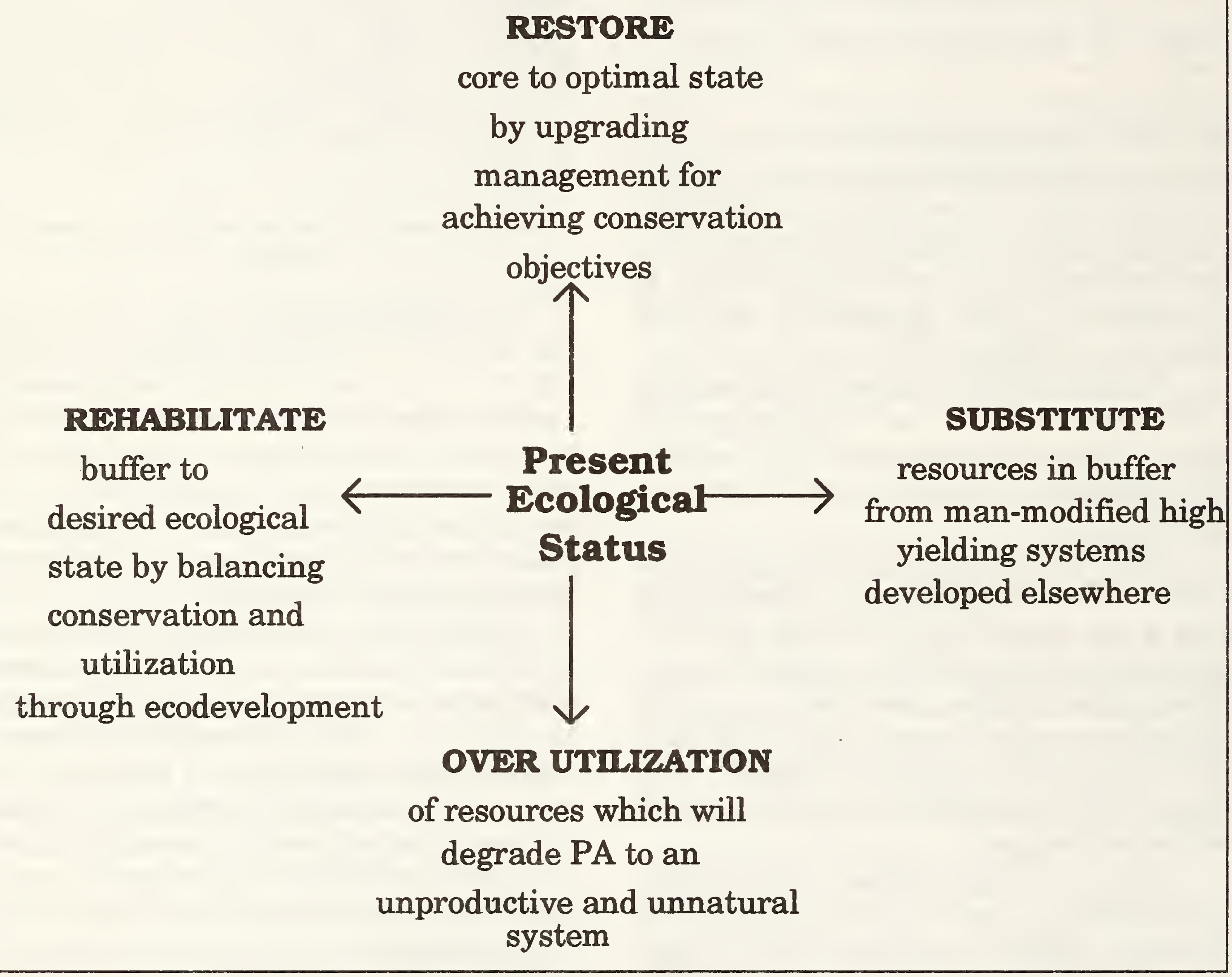
The ratings provided for PAs on the basis of their objectives alone do not necessarily coincide with the ratings based on the three parameters identified as the most important criteria for assessing PAs, namely the Conservation Potential, Utilitarian Potential and the degree of Conflict. This indicates the need for specific management to achieve these goals, or to modify objectives where the probability of achieving them is not feasible.

The basic policy for management of PAs must consider their specific objectives. In important PAs management must attempt to recreate a relatively 'natural' state of the ecosystem in its 'climax' vegetation form. This process of restoration may not be an achievable target in all cases. In certain situations it may not even be a desirable objective as it may be detrimental to certain important species found in non-climax communities. However, this must be attempted in the core areas of most NPs and the more important Wildlife sanctuaries (Box 3 and 4).

A PA's management may only be able to bring about rehabilitation of its ecosystem to achieve a desired level of naturalness. Here its conservation goals and utilization capability are to be balanced judiciously (Box 3 and 4). This option attempts to provide a sustainable use of local resources while maintaining the wilderness in as optimal a state as possible. The process of ecodevelopment and spatial zoning of the PA for resource-use are important management strategies for this option.

Box 3

MANAGEMENT OPTIONS



RESTORE
core to optimal state by upgrading management for achieving conservation objectives

REHABILITATE
buffer to desired ecological state by balancing conservation and utilization through ecodevelopment

Present Ecological Status

SUBSTITUTE
resources in buffer from man-modified high yielding systems developed elsewhere

OVER UTILIZATION
of resources which will degrade PA to an unproductive and unnatural system

In PAs where restoration or rehabilitation, along with sustainable resource utilization, is beyond the carrying capacity of the PA, or if it is likely to erode its resources if over exploited for subsistence needs of local people, these resources must be developed elsewhere and met through substitution. Providing these additional resources is the price that society must pay for the preservation of PAs. This is frequently neglected and it is invariably the poor wilderness dweller who pays the price of conservation. This must be rectified by adequate financial inputs into the IPAS to support people whose resource-use has been restricted to achieve conservation gains. However, this should not be provided in a monetary form but by creating opportunities for achieving a higher socio-economic stability, based on activities that do not place further pressures on the ecosystem.

A combination of basic and supportive management options may be necessary to achieve conservation goals. Different objectives of management must also be specified for core and buffer zones (Box 3 and 4). This has a bearing on the financial outlay for adequate management for restorative and ecodevelopment activities (Box 4).

In terms of management for PAs that have a relatively High Score for their Conservation Potential the ideal method would be to attempt to restore at least a part of the area - the core - to near 'natural' conditions. However, this would depend on the capability of its buffer to have an adequate Utilization Potential so that resource needs can be provided for local people. This could be achieved by rehabilitation of the buffer area. All PAs of a NP status should be able to fulfill this function.

If the PA's ability to support the peoples' basic needs has a relatively Low Score it would be essential to substitute resources from outside the PA. PAs with more serious conflicts require increased financial outlay, larger resource substitutions and more sensitive management. Management strategy must counteract the polarization of the needs of wildlife conservation and those of local people.

The graded system of ascribing scores to PAs provides an important indiactor of the relative status of each PA. This in turn can be used to help select basic management criteria for the individual PAs within the IPAS.

A more detailed and accurate grading could be achieved if several other parameters are quantified and included in the grading scale. In Conservation Potential, apart from factors such as size, biogeographic and ecosystem representation, other factors such as shape, habitat quality, statistically quantified faunal populations and the degree to which species are locally endangered, could all be studied and given a proportionately justifiable weightage. In the Utilization Potential the scoring has taken into consideration parameters such as number of settlements/sq. km and human population density. It should also consider their spatial distribution, the amount of 'malki' land, number of free ranging cattle, the extent of dependence on minor forest produce, etc. which must be graded during a detailed Participatory Rural Appraisal. The type and pattern of tourist pressure must be studied to see if it is within the tourist carrying capacity of the PA. Providing smaller individual units for Conflict levels such as the estimated value of the crop damage, lifting of livestock, and the loss of life and livelihood must be included. However, these issues are difficult to quantify, especially when attempting to put a value on human life. An important objective of a more detailed analysis would be to decide which areas can be included in the Scientific Reserve/Strict Nature Reserve category as per the IUCN, and which areas require a change from Wildlife Sanctuary to National Park status. Other categories such as 'Resource Reserves' or 'Multiple Use Areas' could

Box 4

COMBINED MODES OF MANAGEMENT

	OPTIONS	BASIC MANAGEMENT	SUPPORTIVE MANAGEMENT
Most valued PA	1	RESTORE core +++	RESTORE buffer ++
	2	RESTORE core ++	REHABILITATE buffer +
	3	REHABILITATE core +	SUBSTITUTE resources for buffer (+++)
Least valued PA	4	SUBSTITUTE for whole PA (+++)	

+++ : High financial inputs on ecorestoration.
++ : Moderate financial inputs on ecorestoration.
+ : Low financial inputs on ecorestoration

(+++) : High financial inputs on ecodevelopment
(++) : Moderate financial inputs on ecodevelopment
(+) : Low financial inputs on ecodevelopment

Box 5

BIODIVERSITY PRESERVATION

Species level → Preservation
- → Waterfowl breeding areas (Ujjaini)
- → Wolf, endemic fish (mahseer), Giant squirrel
- → Western Ghats flora
- → Major Predators (Tiger, Leopard)
- → Western Ghats Amphibia
- → Medicinal Plants

Landscape Level
- → Semi - arid grasslands (After reduction of GIB) → Notify other grasslands
  - a) Semi-arid
  - b) Coastal
- → Western Ghats forests → New PAs: Mahableshwar, Fr. Santapau
  Corridoring existing PAs
- → 'Unique' areas; → Coral reef, mangrove, coastal grasslands,marshes
  Bird breeding colonies, marine flora and fauna

LOCAL FACTORS

GIB → Extremely large unviable PA → Reduce in size → Local requests for MIDC

All Western Ghat PAs → Fragmentation → Establish Corridors (Convert RF to PA status)
High Biodiversity No timber value in ESAs

Wetland PAs → Conflict with Fishing

All Forest PAs
- → Crop Damage by Wild Boar and Deer
- → Conflict due to free grazing by scrub cattle

Melghat → Proposal for reduction in size → Inadvisable → Largest viable Protected Area
Tigers need large home ranges

Malwan → Severe conflicts with fishermen → Specific ecodevelopment
Only known coral reef

Phansad → Small size → Increase size
Only Protected Area with primarily a coastal forest, etc.

Bhimashankar → Devarais → Triggered Conflict

Radhanagari → Threatened by Mining

Koyna → Relocation of Settlements

Sanjay Gandhi → Human Encounters with Leopards

Rehekuri, GIB → Crop Damage by Blackbuck

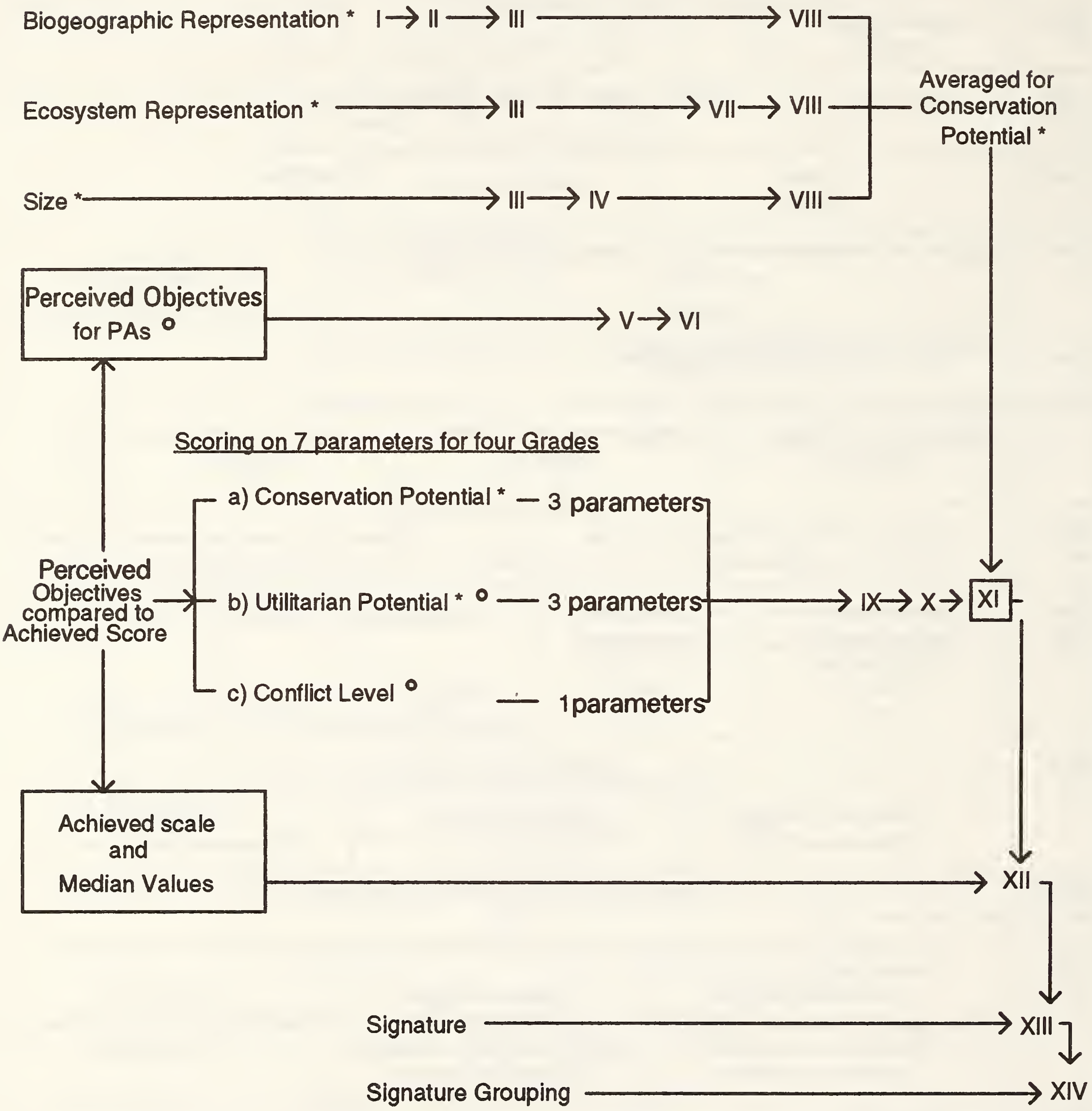
Navegaon → Naxalite Problem

IMPRESSIONS
EVOLUTION OF THE NOTIONAL VALUES

Table I	Biotic Province	Total landmass of Maharashtra (sq. km)	(A) % in each biotic province	Area under PA at present (sq.km) (sq. km)	(B) % of area in PA network	Area in PA if GIB reduced in size	(C) % of area in PA network GIB	
Table II	Biotic Province (Table I)	A		B	B-A	C	C-A	Value 1-3
Table III	Ecosystems	PA	Status	Size	Biotic Province (Table II)	Ecotype	Number of PAs	
Table IV	Size (Table II)	Notional Value 1-3						
Table V	Specific Objectives (Perceived)	Score based on 12 parameters	0-3 : High Grade 4-6 : Moderate Grade 7-9 : Low Grade					
Table VI	Value for Objectives - Grading Method							
	Maximum no. of Primary Objectives 4	Maximum no. of Secondary Objectives 3	Maximum no. of Tertiary Objectives 2	Total 9				
Table VII	Number of PAs of Different Ecosystems (Table III)	Notional Value based on common/rare types 1-3						
Table VIII	Biogeographic representation in biotic province (Table II) 1-3	Ecosystem representation (Table VII) 1-3	Size (Table IV) 1-3	Total 3-9	Average 1-3			
Table IX	Scoring Values - 7 Parameters							
	Conservation Potential (3 parameters: 0-3)	Utilization Potential (3 parameters: 0-3)	Conflict Level (Opportunistic parameters: 0-3)					
Table X	Score Values for 4 grades for each Potential 0-9							
Table XI	Scoring Status Conservation Potential Biogeographic Importance (Table VIII) Natural Vegetation/Wildlife (Subjective estimates)	Utilization Potential Timber (Questionnaire) FFF (Human/Cattle Population) Tourism (No. per year)	Conflict Level Human/Cattle kills, Crop damage, etc. (Questionnaire)					
Table XII	Ranking Status PA Name Conservation Potential (Table XI) Median Value-5	Utilization Potential (Table XI) Median Value-4	Conflict Level (Table XI) Median Value-4	Rank Achieved	Rank Perceived (Table V)			
Table XIII	Conservation (Table XII)	Utilization (Table XII)	Conflict (Table XII)	Signature				
Table XIV	Signature Grouping	Grade I: Good	Grade II: Average	Grade III: Poor				

EVOLUTION OF THE RATABILITY OF PAs BY SCORING

(Information transfer through Tables to achieve a high degree of rating sensitivity


Biogeographic Representation * I → II → III → VIII
Ecosystem Representation * → III → VII → VIII
Size * → III → IV → VIII
Averaged for Conservation Potential *
Perceived Objectives for PAs °
V → VI
Scoring on 7 parameters for four Grades
a) Conservation Potential * — 3 parameters
b) Utilitarian Potential * ° — 3 parameters
c) Conflict Level ° — 1parameters
IX → X → XI
Perceived Objectives compared to Achieved Score
Achieved scale and Median Values
XII
Signature
XIII
Signature Grouping
XIV

* - Information based on hard data

° - Information based on Questionnaires and Opportunistic Observations also emerge from a more detailed study and help to formulate a graded management strategy for the PAs in relation to the needs of the IPAS.

This study indicates that a rational, progressively developed scaling system of assessment could be a valuable management tool if evolved further along the lines suggested. Scoring systems cannot be perfect, as some of the parameters must be based on subjective impressions. This limitation is inherent to such an exercise. The only possible method of reducing this bias is by consciously avoiding a personal evaluation of the overall rating of a PA. A consensus of views from different experts and multiple quantified parameters would make it more objective.

A more detailed field survey system could be evolved, that would assess the conservation potentials, utilitarian potentials and the conflict levels in as short a period as possible. Evolving such 'Rapid Assessment Techniques' (R.A.T.) for both conservation status and socioeconomic conditions has been attempted in a pilot study of the Bhimashankar sanctuary (Bharucha 1991).

The complexity of using a larger number of parameters for evaluating large numbers of PAs is that it would require a computer model designed specifically for this purpose. The exercise would be invaluable in rating PAs in the IPAS and in

Annexure I

HUMAN AND CATTLE POPULATION INSIDE PROTECTED AREAS

Responses from PA managers to assess human population pressure and cattle grazing.

Name of PA		Human Population			Cattle Population			Agri
	Size in ha.	1971	1981	/ha	1971	1981	/ha	area in ha.
Forests - Western Ghats								
Radhanagari	35100			-			-	
Kalsubai	36200			-			-	
Bhimashankar	13100	-	2879	219	-	3520	0.268	5127
Koyna	41900			-			-	
Chandoli	30900			-		-	-	
Sanjay Gandhi	10300	-	924	0.089	-	-	-	-
Phansad	7000			-			-	-
Karnala	400	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Forest-N & NE								
Melghat	161600	-	16120	0.099	-	1063	0.130	10984.6
Pench	25700	460	680	0.026	411	498	0.019	32.5
Nagzira	15300	-	306	0.02	-	201	0.013	90.2
Andhari	50900	1851	1757	0.034	1728	2254	0.044	433
Painganga	32500	-	21781	0.670	-	14886	0.458	17922.6
Gautala	26100	-	17526	0.671	-	17403	0.666	23698.7
Yawal	17600	-	1943	0.110	-	1942	0.110	611
Navegaon	13400	-	290	0.021	-	582	0.043	229.5
Tadoba	11700	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Grassland and Scrubland								
GIB (only part)	849600	621000	882359	1.038	658583	721290	0.848	10384
Aner Dam	8300	940	1887	0.227	400	464	0.055	257
Katepurna	7400	-	425	0.057	-	471	0.063	1525.8
Rehakuri	200	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Wetlands								
Nandur-Madhmeshwar	10000	-	19424	-	-	-	-	

Note:- Protected Areas and Wildlife Conservation in Maharashtra, E.Bharucha - A Report for the World Bank, 1991.
The data is incomplete. As in some cases settlements which are located within the PA have been excluded from the notification.
(Source:-Protected Areas and Wildlife Conservation in Maharashtra E.Bharucha - A Report for the World Bank, 1991)

Annexure II
FUEL AND FODDER
RESPONSES FROM PA MANAGERS TO ASSESS FUEL AND FODDER NEEDS OF SETTLEMENTS

Name of PA	FUEL	FODDER
Forests Western Ghats		
Radhanagari	Locally, pvt. forest	Locally
Kalsubai	From PF	Pvt. land & Plantation
Bhimashankar	Malki & forest	Malki area
Koyna	Own area	Own area
Chandoli	Malki & forest	Malki area
Sanjay Gandhi	From PA	From PA
Karnala	PA & Panvel range	Varkas and pendha
Phansad	Malki land & PA	Govt. Forest
Forests N & NE		
Melghat	Forest area	Forest area
Pench	Adjoining Areas of PA	From PA
Nagzira	Agri. waste, Forest area & PA	PA, Forest & Pvt. Land
Andhari	Pvt. land, Forest area & depot	Forest area & Pvt. Land
Painganga	Pvt. land & PA	From PA
Gautala	Pvt. land & PA	Pvt. land & PA
Yawal	From PA	From PA
Navegaon	From PA and Adjoining forest	From PA and Adjoining forest
Tadoba	(No villages)	(No villages)
Grassland and Scrubland		
Sagarehwar	(No villages)	(No villages)
GIB	Malki & market	Gairan, pvt. & market
Aner Dam		
Katepurna	PA	PA
Rehakuri	(No villages)	(No villages)
Wetlands		
Nandur-Mad.	Private land	

Note:- Protected Areas and Wildlife Conservation in Maharashtra, E.Bharucha - A Report for the World Bank, 1991.

providing the basis for rational management and financial disbursement to the component PAs.

This study which has been based on 29 PAs of Maharashtra, thus could form a model for a larger analysis. Similar studies could thus be undertaken for the more than 500 PAs now notified in India, to provide an overall picture of the status and position of each PA in the country.

CONCLUSION

An IPAS designed for Maharashtra must have an implementable strategy (Annexure III). Apart from preserving biological diversity and natural ecosystems, it must protect soil and water regimes, provide for the needs of the surrounding local people and thus gain acceptance as a necessary part of good land use planning (Conserving the Worlds Biological Diversity, 1990; Caring for the Earth, 1991). It must also consider the financial implications of setting aside land for conservation (Smith 1990, Phillips *et al.*, Dixon and Sherman 1990, Calish *et al.* 1978). The possible changes that must be considered are indicated in Annexure IV.

As shown in Part A, the selection of existing PAs is not based on objective criteria. They do not constitute a rationally designed IPAS for Maharashtra. The status and size of some PAs should be redefined according to the set of principles enumerated above. Size alterations are also indicated. Besides this, several new PAs need to be notified and their specific objectives clearly defined (Rodgers and Panwar 1988). The PAs must fit into the overall IPAS and funds be allocated in accordance with their relative merits and importance (Kothari *et al.* 1989).

Part B of this paper shows that the components of the IPAS, i.e. the existing PAs require to be based on a rational set of management options. This would indicate the amount of manpower and financial support necessary for achieving their perceived objectives. At present the distribution of both appears to be on an *ad hoc* basis, with no relevance to the needs of individual PAs. Identification of the relative position and status of a PA, based on its rating in the IPAS, provides rational guidelines to select the policy most relevant to its management. Financial resources can be more rationally utilized according to these priorities. At present the only guidelines from the Government of India are based on the size of the PA which is seen to be irrelevant. If this were to be followed, 50% of the Wildlife Wing staff would have to be deployed to guard agricultural crops in the Great Indian Bustard Sanctuary, as this constitutes 50% of the IPAS! They would be looking after about a dozen highly localized and seasonal bustards, while the rest of the 28 PAs would be left to fend for themselves!

Since nearly all the existing PAs have a large number of local people who are highly dependent on their resources for their daily needs, especially for fuelwood and fodder, this requires a totally new management approach. This is even more relevant in Maharashtra due to the absence of alternate land for resettlement of PA villages. Though there is little scope for relocating them outside PAs, providing alternate locations within the PA is however a possible option. This is especially relevant in situations in which people are themselves keen to move to a more suitable location. Reducing the human impact on the PA must become a prime issue for successful implementation of the IPAS. This needs comprehensive, site specific, ecodevelopment programs that must be integrated into the Management Plan of each PA. It is essential to identify the quantum of resources required, and to allocate land to develop them by joint management between the people and the Forest Department. Just as a habitat evaluation and wildlife census is essential to study the biological aspects of each PA, a study of the effects of biotic pressures is essential to provide data on the impact of the PA on these communities through a Participatory Rural Appraisal (P.R.A.).

The level of conflict is an important issue and a variety of site and issue specific measures, to mitigate conflict, must be identified if the PAs are to be given long-term prospects of survival.

Though based on some subjective and other quantified parameters, the evaluation scale designed in this paper provides a set of rational guidelines for assessing PAs. These can be refined and the number of parameters increased and quantified by detailed field studies to improve accuracy. There is however, a great need to standardize methods that can be widely used under different situations. This would permit a more objective analysis of conservation assets at the global and national levels. As stated by Stewart and Sullivan (1994), "an important area for continued research and dialogue is the development of a global system for landscape classification by habitat type which is needed to underpin priority site selection..." According to their paper, it is important in future for organizations such as the IUCN to identify, "valid methods of selecting priority sites using objective, scientifically based criteria."

An important need is to establish 'special objective PAs', to act as model management areas. For example to (a) manage 'Multiple Use Areas' as suggested for the proposed Ujjaini Bird Sanctuary where aquatic avifauna and fishing can co-exist (Bharucha and Gogate 1990); (b) to protect an endangered species, such as the endemic Mahseer fish at Lonavala, the Giant Squirrel in the Western Ghats and for the several endemic plants of the Sahyadris in the Deorais in a "cluster PA" (Bharucha 1991); (c) increase public awareness for conservation, for instance at the Mula-Mutha Bird Sanctuary - Pune; and the Sanjay Gandhi National Park, Pench and other PAs which have a large number of visitors and d) to identify corridors for existing PAs in the Western Ghats. The last is of great importance to species whose gap crossing ability is relatively low (Dale *et al* 1994).

Several areas of conservation value have been recently identified as potential sites to be included in the PA network. Still others require careful selection to create a balanced bio-geographical representation in the IPAS. New areas must be selected to protect areas having high levels of biodiversity, or which have relict ecosystems, or those that harbor endangered species outside the present IPAS. (Bharucha 1991, Rodgers and Panwar 1958; Conservation of Mangroves in India 1990; Conservation of Wetlands in India 1989).

Some PAs need to be given a higher conservation status by upgrading them from Wildlife Sanctuaries to National Parks. Others require an addition to their existing size, or a redemarcation of their boundaries (Annexure IV).

A rational IPAS established and supported by Government and people is an essential requirement to preserve the valuable biological resources of the State of Maharashtra. This is as important as the development of agriculture and industry. Notifying land as Protected Areas creates an asset that has immense long-term economic implications which have not been fully appreciated. An IPAS for Maharashtra is a basic requirement of good land-use planning for the future well-being of the State.

Annexure III
IMPLEMENTATION OF AN IPAS

1.1 Selection of PAs based on biogeographic and conservation values.
1.2 Management planning for component PAs based on site specific objectives.
1.3 Notification of new PAs on a biogeographical basis.
1.4 Strengthening of the Wildlife Wing of the Forest Department.
2.1 Integrating ecodevelopment activities for dependent settlements into PA management plans.
2.2 Mitigating people-wildlife conflict.
3.1 Completing legal processes of notification of PAs.
4.1 Upgrade research and training facilities for wildlife preservation and PA management.
5.1 Reorganizing wildlife tourism.
6.1 Increasing public support through a comprehensive conservation awareness programme using target specific mass media programmes.
6.2 Integrating conservation biology and resource management into school and college curricula and establishing Nature Awareness Areas at Taluka level.
7.1 Improving conservation oriented inputs in Multiple Use Areas outside the IPAS.
8.1 Providing financial support and expertise for *ex-situ* conservation and re-introduction of threatened or vulnerable plant and animal species.
9.1 Integrating the IPAS into an overall land-use strategy for the state.

Annexure IV
RECOMMENDED CHANGES TO RATIONALIZE AN IPAS IN MAHARASHTRA

I. New PAs*: To balance representation on biogeographical basis.

a) Forests: Rev. Fr. Santapau - Lonavala; Western Ghat Deorais - cluster PA; Mahabaleshwar; Bhamragarh; Darekasa; Sironcha potential Jerdon's courser habitat); Tipagarh - Ghadchiroli.
b) Grass-Scrubland: Mahadeo range - Satara (wolf sanctuary); Sonurli - Chandrapur (wolf sanctuary); Lonar crater; Nandgaon; Gnanganga; Akola; Kolhapur; Wadali; Lalling- Dhulia; Ramlingghat - Osmanabad.
c) Wetlands: Ujjaini (Bhigwan); Mula-Mutha - Pune; Itiadoh - Rajoli; Tipeshwar; Mayeni.
d) Coastal: Roha; Vikhroli; Dasgaon; Akhra; Turtle beaches; Arabian Sea Islands.

* Some of these would require NP status.

II. Proposed changes in size or redemarcation of present PA boundaries:

a) Increase size: Andhari and Tadoba; Navegaon; Nagzira; S. Gandhi, Phansad and Karnala.
b) Reduce size: Great Indian Bustard Sanctuary.
c) Redefine boundaries: This is necessary for a large number of PAs to include vital corridors or adjacent wilderness. Or to exclude valueless degraded areas. This may or may not involve a change in size.

III Proposed changes in status of present PAs:

a) Upgrade (W-L Sanctuary to NP): Melghat, Koyna, Radhanagari.
b) Downgrade : None at present.

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CONSERVATION PRIORITIES FOR THE ANDAMAN ISLANDS

PRIYA DAVIDAR[1]

A survey was conducted in the Andaman Islands to look at the distributional patterns of forest birds and butterflies. These two taxa were used as indicators to see what type of reserves would best conserve the biodiversity. This study showed that forests on large islands and undisturbed evergreen forests are important reservoirs of biodiversity in the Andaman islands.

INTRODUCTION

The Andaman and Nicobar chain of islands lying in the Bay of Bengal between 6° 45' N and 13° 41' N latitude have a rich and varied biota, both terrestrial and marine. These unique ecosystems are under increasing pressure from human activities (see Saldanha 1989, Whitaker 1985), and unless protected, will be decimated rapidly. More than a hundred protected areas, namely Sanctuaries and National Parks have been earmarked in the Andaman and Nicobar islands (Pande *et al.* 1991). Although this sounds impressive, their importance for the conservation of biodiversity needs to be examined (Davidar *et al.* 1995).

In order to see where and what type of reserves are needed to protect the terrestrial biota, a rapid assessment was conducted in the Andaman group of islands using two taxa, forest birds and butterflies. Forty seven species of forest birds were selected using Ali and Ripley (1987) and from field observations. These were surveyed on 45 islands and butterflies on 25 islands. This was not meant to be precise or exhaustive, but to give a quick and approximate estimate of species and their distributional patterns. Most of the results of this study have been published or are under publication (Davidar *et al.* 1995, Davidar *et al.* in press, Devy *et al.* in press). In addition to this, general information gleaned from many field trips gave a good grasp of what should be the focus of conservation efforts.

STUDY SITE

The Andaman chain of islands, about 6000 km^2 in area, are considered to be a continuation of the Arakan Yoma chain of Myanmar. It is separated from the Nicobar group of islands by the 10 degree channel. These islands are considered to be truly oceanic as they were never completely separated from the continent during the Pleistocene glaciation (Ripley and Beehler 1989). Most of the land mass is made up of large continuous islands such as North, Middle, Baratang, South and Rutland islands. The Little Andamans, another large island lies about 67 km south. This large island mass is surrounded by smaller islands and archipelagos. Human colonisation of the Andamans has been limited by water. The climate is tropical and oceanic with rainfall from both the SW and NE monsoon winds. There is a climatic gradient from the North to the Little Andamans with the north having a drier and more seasonal climate. Thus the North Andamans have predominantly drier forests whereas the South Andamans have more evergreen forests, (Davidar *et al.* 1995).

METHODS

The surveys were carried out in the dry seasons of 1992, 1993 and 1994. A total of 45 islands were surveyed for forest birds and 25 for butterflies. The survey covered the North Andaman islands and islands surrounding it, Baratang Island, Ritchie's archipelago and other islands off the Middle Andamans. The South Andamans and Labrinyth archipelago, Rutland and the Little Andaman Island. Different sites and vegetation types were selected on the large islands whereas the smaller islands were completely surveyed. Transects were selected in a site on an island. The vegetation types were noted. Forest birds seen or heard along the transect were recorded between 0700 h and 1000 h. Transects were walked separately for butterflies and species seen 5 m on either side of the transect were recorded. For more detailed methodology see Davidar *et al.* 1995. The sampling was repeated in each site for several days until no new species were recorded.

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RESULTS AND DISCUSSION

Importance of Forests on large islands: This survey clearly showed that forests on large islands are very important in the conservation of biodiversity. All the 47 species of forest birds and 57 species of butterflies (out of a total of 65 species recorded in this survey) were recorded on islands larger than 30 km^2 in area. Islands smaller than 1 km^2 had records of 36 species of forest birds and 39 species of butterflies. On islands less than 0.1 km^2 in area, only 20 species of forest birds and 21 species of butterflies were recorded.

Of the forest birds recorded, *Coracina striata, Chrysococcyx xanthorhynchus, Oriolus xanthornus* and *Terpsiphone paradisi* were not recorded on islands smaller than 30 km^2 (Davidar *et al.* 1995). This non random distribution of forest birds suggests that small islands, however numerous, are not equivalent to large islands for the conservation of biodiversity.

However, 58 of the reserves in the protected area network are smaller than 1 km^2 and of these 13 are less than 0.1 km^2 in area (Pande *et al.* 1991). Only 4 of the reserves are larger than 30 km^2. As forests on large islands are not adequately represented in the current protected area network, it is important that remaining patches of primary forests on large islands are protected on a priority basis. These patches should be large enough to include the vegetational and habitat diversity and adequate numbers of the rarer species.

Importance of wet evergreen forests: The study shows that many of the butterfly species recorded, for which adequate data exists, were recorded only in evergreen forests (Devy *et al.* in press). Of the 65 species of butterflies recorded, 25 appear to be habitat specialists, and of these 10 were evergreen forest specialists. The presence of evergreen forests on an island significantly increases its butterfly diversity (Devy *et al.* in press). Islands off the main North Andaman island which have deciduous forests have fewer species of butterflies than islands of equivalent sizes off the South Andaman island with evergreen forest. While this could be a seasonal phenomenon, it is well known that many tropical butterfly species are habitat specialists and many are adapted to tropical wet forests and the loss of these forests will result in the extinction of many species (see Devy *et al.* in press). The primary wet evergreen forests of the Andaman islands are being destroyed and degraded at an alarming rate by forestry operations and encroachments. These forests should be protected on a priority basis.

Unique species: Species such as the Narcondam Hornbill (*Aceros narcondami*) which are found only on Narcondam island, and the Andaman teal (*Anas gibberifrons*) which depend on transient water bodies deserve particular attention. The Narcondam Hornbill enjoys protection, and the ecological requirements of the teal need to be studied and certain areas set aside for its protection. Likewise too for unique species of plants, invertebrates, reptiles, amphibians, etc.

Management Issues: As there is a north-south vegetational gradient, reserves should ideally be located along this gradient. Reserves should also be of sufficient size to include the habitat and vegetational mosaic.

The North Andamans has the Saddle Peak National Park which has stunted evergreen forest. However, this Park is poorly managed, with intense grazing pressure from domestic animals and encroachments. The Kalpong Hydel project in the North Andamans will further reduce the extent of evergreen forest by submersion (Ellis 1989). The Jarawa tribal reserve which covers a fairly large area in the Middle and South Andamans acts as a de facto protected area. However, the survival of the forests and the tribals are increasingly under threat from illegal logging and encroachments. This area should be strictly protected from external threats.

There are no protected areas on Ritchie's archipelago, where primary forests are found in inaccessible areas of Havelock and on small islands such as Wilson. Forests on the other large islands such as Peel, John Lawrence and Henry Lawrence are mostly degraded. Therefore, the primary evergreen forests still remaining in the Ritchie's archipelago should be protected.

Evergreen forests in the South Andamans are protected in Mt. Harriet and the Wandoor Marine National Park, which has many forested islands. Rutland is heavily deforested, but areas of forest still remain which can be protected.

The Little Andamans is a large and isolated island. Its geographic isolation accelerates speciation processes and also makes the species more vulnerable to extinction. A large area of primary forest can be declared a National Park and in this Centenary year of Dr. Sálim Ali, can be named after him. It will be a fitting tribute to him. Protecting large areas of forest on the large islands will be adequate to conserve the vegetational mosaic and species diversity. The other problem is the management and protection of these reserves under difficult field conditions. Even professional ecologists often find it difficult to do extensive field work, and one cannot expect the less motivated forest staff to work miracles. While small, isolated islands are naturally protected, it will be difficult to protect forests on the large islands. Infrastructural facilities, staff and equipment are needed to protect these reserves. Imaginative and well regulated ecotourism could be a potential source of revenue and tribals such as the Onges could play an important role in reserve management.

ACKNOWLEDGEMENTS

While preparing this manuscript for the Sálim Ali Centenary issue of the Journal of the Bombay Natural History Society, I found a letter from Dr. Sálim Ali from which this excerpt is taken. It was with regard to participation in a symposium held in November 1977. It summarises his expectations of his students and the high standards he set for them.

'Yes, I do expect you to have something ready for the Symposium that does not let you or me down. All who are or have been my students, or whose interest in birds has been influenced in any degree by my work, are expected to participate actively. I shall be disappointed if you do not present something, and am rash enough to believe that what you do present will be worthwhile.'

This paper is dedicated to the memory of Dr. Sálim Ali, teacher and guide. His dedication and professionalism, kindliness and humour will never be forgotten.

This study was made possible through numerous field trips sponsored by Pondicherry University. The Ministry of Environment, France, funded the survey. I am grateful to the Forest Department, Andaman and Nicobar Islands for permission to conduct this study and for help at all times. I am deeply indebted to my students, Soubadra Devy, T. Ganesh, T.R.K. Yoganand and N. Joshi for carrying out the survey under difficult field conditions. Dr. J.M. Thiollay contributed greatly to developing this project and to data collection in the field.

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IMPACT OF HUMAN ACTIVITIES ON THE RANGING BEHAVIOUR OF ELEPHANTS IN THE NILGIRI BIOSPHERE RESERVE, SOUTH INDIA

AJAY A. DESAI AND N. BASKARAN[1]

(*With a text-figure*)

INTRODUCTION

Today we find that many animal species throughout the world are threatened with extinction or are becoming increasingly endangered. The situation is even more severe in the developing countries, where the limited resources available for conservation and growing populations with their demand for new land make conservation a truly challenging task. The primary reason for this deplorable situation has been man. Humans have reduced most natural habitats into islands surrounded by land developed for human use. Today, we are faced with a situation where, even if the killing of threatened animals is stopped, there may not be adequate habitat left for them to live in.

An added problem is that of human-animal interactions at the interface of these remaining natural habitats and their surrounding human use areas. As no hard boundaries demarcate the two, there tends to be a diffuse border which results in some animals intruding into the human use areas and causing problems. At the same time humans intruding into the surrounding natural habitat and exploiting its resources results in the degrading of the natural habitat.

The problem caused by animals has been studied in great detail. Taking into consideration only Asian elephants (*Elephas maximus*), studies have been done by Blair *et al.* (1979), Balasubramanian *et al.* (1995); Datye and Bhagwat (1995); Desai *et al.* (1995); Desai and Krishnamurthy (1992); Fernando (1990); McKay (1973); Mishra (1971); Olivier (1978); Ramesh and Desai (1992); Ramesh and Sathyanarayana (1995); Seidensticker (1984) and Sukumar (1985, 1989 and 1990). They range in scope from reporting the problem to quantifying the damage, and discussions on causes for the conflict. The present study does not deal with this issue but looks at how elephants react to human presence and activity within their range.

Studies on the impact of human activities on the adjoining natural habitat have been mostly restricted to the study of human dependence on forests and the consequent degradation of natural habitats (Daniel *et al.* 1987, Johnsingh, Prasad and Goyal 1990, Silori and Mishra 1995, Wesley, Mishra and Johnsingh 1995, Ramesh 1995). While these studies have looked at resource depletion and disturbance, and attempted to relate these factors to the use of the affected areas by elephants, all have failed to take into account the behaviour of elephants. What is lacking in all the earlier research is the study of how elephants actually react to human activities within their ecosystem, while taking into account the social organization and ranging behaviour of elephants.

Social organization and ranging behaviour: In the study area females live in clans while adult males (henceforth referred to as bulls) are mainly solitary. These sub-units (clans and bulls) have different strategies for habitat utilization with well defined home ranges; with seasonal ranges within home ranges and regular routes or migration paths between these seasonal ranges. Thus human impact should affect different sub-units (clans or bulls) differently, depending on the location of their home ranges, seasonal ranges, migration routes, and the degree and type of use of the interface area by individual sub-units and not uniformly by the population as a whole.

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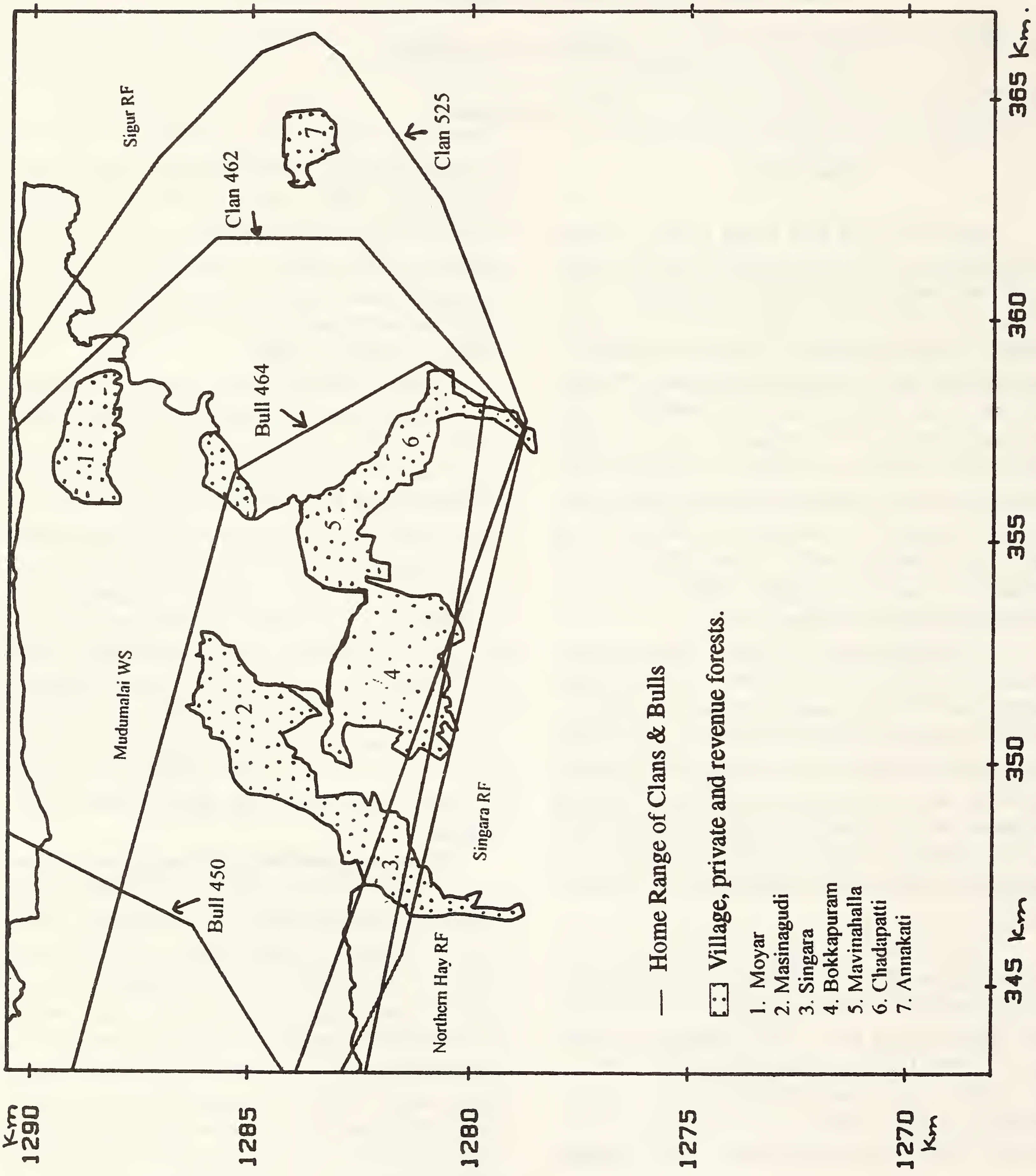
Sigur RF
Clan 462
Clan 525
Bull 464
Mudumalai WS
Bull 450
Singara RF
Northern Hay RF
1
2
3
4
5
6
7
— Home Range of Clans & Bulls
Village, private and revenue forests.
1. Moyar
2. Masinagudi
3. Singara
4. Bokkapuram
5. Mavinahalla
6. Chadapatti
7. Annakati
345 Km
350
355
360
365 Km.
1290 Km
1285
1280
1275
1270 Km

Fig. 1. Study area of Nilgiri Biosphere Reserve

The present study highlights the impact of human settlements and activity on the ranging behaviour (range use) of elephants while taking into account the social organisation and ranging behaviour of the elephants. The findings of this study are not only applicable to the present study area but also to other elephant habitats where elephant ranging still remains normal (not modified by man).

OBJECTIVE

The main objective was to determine how human activities influence the ranging behaviour of elephants, while taking into consideration that elephant populations have well defined sub-units (clans and bulls) and also that these sub-units have well defined home ranges, seasonal ranges and migration routes within them. We wanted to test the following hypothesis.

Hypothesis: "Clans and bulls use areas with and without human disturbances equally".

STUDY AREA

The Nilgiri Biosphere Reserve lies at the tri-junction of three southern states (Karnataka, Tamil Nadu and Kerala) and covers an area of 5520 sq. km. This area is one of the best elephant ranges for conservation of Asian elephants in Asia (Desai 1991). The study covered the eastern part of Mudumalai Wildlife Sanctuary (MWS) in Tamil Nadu. In addition, the study also covered the adjoining Reserve Forest and Revenue Forest which were used extensively by the study animals.

Mudumalai and the surrounding reserve/revenue/private forests have a rainfall gradient from 600 to 2000 mm with the western part getting the highest rainfall. The vegetation follows a similar gradient changing from Southern Tropical Thorn Forest in the east to Tropical Moist Deciduous Forest in the west and in between lie the Tropical Dry Deciduous Forests (for details of the study area refer Daniel *et al.* 1987, Sivaganesan 1991).

In the study area there are human settlements within and outside (abutting) the elephant range. These areas vary in size from a few houses to large villages, with a human population of several thousands.

METHODS

Study animal: This study was based on the ranging behaviour of two clans (clan 525 and clan 462) and two bulls (bull 450 and bull 464) in the study area. These two clans and two bulls had been radio collared in 1991 along with a third clan (clan 522). Data on various aspects of ranging and behaviour have been collected since 1991 on all these radio collared elephants (Balasubramanian, *et al.* 1995, Baskaran, *et al.* 1995 and Desai *et al.* 1995). The main reason for including only four radio collared animals in the present study was because of their normal ranging behaviour. The fifth animal, Clan 522, had shifted its range (Desai *et al.* 1995) and we felt that it was best not to include it in the present analysis. The two clans represented the ranging behaviour of the females, while the two males, though of different ages, were adults and represented adult male behaviour to a large extent.

Selection of study site: As all the four collared elephants have different (to a certain degree) patterns of ranging, we felt that it would be best to compare their ranging in an area where it had the greatest similarity. In addition, the study site would also have to be an area where human presence (settlements) and human impact on surrounding habitat was most pronounced, so that the elephants' reaction to such areas could be studied easily.

The present study area covered the eastern end of the home range of all four study animals. The cut off point to the west was 76°32' E longitude and extended up to the eastern end of the study animals' home range as defined by *minimum convex polygon* method (Dalke 1938, Mohr 1947). This included the eastern part of Mudumalai Wildlife Sanctuary, Sigur, Singara and Northern Hay Reserve Forests, some Revenue Forests and private forests (Singara estate). Here all the ranges overlap to a large degree and the influence of habitat and human presence (impact) would be the most common or similar (to a large degree) for all the study animals.

Desai (1991) and Baskaran *et al.* (1995) have shown the importance of home ranges and corridors that facilitate movement of clans and bulls between seasonal ranges. These studies have also highlighted the critical corridors in the Nilgiri Biosphere Reserve (NBR), especially the ones in the northern part of NBR in the Moyar-Masinagudi-Singara area, the same area covered by the present study. This area is a mosaic of human settlements and forests, and over time human activities have spread deeper into the elephant habitat and also increased in intensity. This area provides adequate opportunity for elephants to encounter and react to human settlements and activity.

Analysis: We took into consideration two important variables. First we considered water which is known to play a major role in their distribution (Viljoen 1989, Western 1975 and Williamson, 1975), and as such, water would have a great influence on the way in which clans and bulls used their home range. The second variable was the presence of human settlements (villages) and by extension, human activity and impact on the elephant habitat surrounding these settlements. This would show how the presence of human settlements in an area influenced the elephant's use of the habitat in their vicinity.

Taking these two variables into account, we divided the study site into four areas as follows:

1. Areas < 2 km from a main water source and > 1 km from a village;
2. Areas < 1 km from a village and > 2 km from a water source;
3. Areas < 2 km from a water source and < 1 km from a village;
4. Areas > 2 km from a water source and > 1 km from a village.

These areas are henceforth referred to as "water area", "village area", "water+village area" and "other forest area" respectively.

We considered that the proximity (< 2 km) of a water source or a village (< 1 km) would have maximum influence on the ranging and habitat utilization behaviour of elephants. The influence of both these important factors will certainly extend beyond the distance taken into consideration for the present study but we feel that it would be most apparent and measurable within the distances selected.

The use of these areas was tested for preference and avoidance using the method described by Neu *et al.* (1974) and Byers *et al.* (1984). All four areas were tested together first and then the influence of water and villages were tested separately to study their individual influence on ranging behaviour. All these variables were tested for individual clans and bulls separately.

Study period: The study was carried out from October 1994 to March 1995 (six months) but data from the earlier radio-telemetry study (February 1991 to September 1994) were also used for the analysis.

RESULTS

A total of 471 and 436 locations for Clans 525 and 462 respectively were used for the analysis. For the bulls 464 and 450, a total of 236 and 51 locations respectively were used for the analysis. This data represents only those locations when the study animals were within the present study site and not the entire data set of their ranging within their complete home range.

Of the different areas, "water+village area" (20.8%) and "village area" (4%) together constituted 24.8% of the study site. Human dependence on water is clearly highlighted by the fact that nearly 86% of the village area (area <1 km from a village) lies within 2 km from a water source. Thus nearly a quarter of the study area was within 1 km of a village and therefore exposed to high levels of human activity and subject to severe human impact on the habitat. Of the remaining 75.2% of the study area, "water area" constituted nearly 39.6% while 35.6% was "other forest area". All clans and bulls had access to all these areas, bull 450 did not use the easternmost area of the study site, but (unpublished) data collected

TABLE 1

AVOIDANCE AND PREFERENCE SHOWN TO DIFFERENT AREAS BY CLAN 525.

Area type	Exp. use	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
"water"	186.41	248	0.396	0.469	0.584	*
"water+village"	98.15	95	0.208	0.155	0.248	
"village"	18.74	1	0.040	0.000	0.007	*
"other forest area"	167.63	127	0.356	0.219	0.321	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at $P<0.05$.

TABLE 2

AVOIDANCE AND PREFERENCE SHOWN TO DIFFERENT AREAS BY CLAN 462

Area type	Exp. use	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
"water"	172.56	320	0.396	0.681	0.787	*
"water+village"	90.86	51	0.208	0.078	0.155	*
"village"	17.35	1	0.040	0.000	0.008	*
"other forest area"	155.17	64	0.356	0.104	0.189	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at <0.05.

TABLE 3

AVOIDANCE AND PREFERENCE SHOWN TO DIFFERENT AREAS BY BULL 464

Area type	Exp. use	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
"water"	93.40	39	0.396	0.105	0.226	*
"water+village"	49.18	124	0.208	0.444	0.607	*
"village"	9.39	50	0.040	0.145	0.278	*
"other forest area"	83.99	23	0.356	0.049	0.146	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at $P<0.05$

TABLE 4

AVOIDANCE AND PREFERENCE SHOWN TO DIFFERENT AREAS BY BULL 450

Area type	Exp. use	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
"water"	20.18	34	0.396	0.502	0.832	*
"water+village"	10.63	1	0.208	0.000	0.068	*
"village"	2.03	1	0.040	0.000	0.068	
"other forest area"	18.15	15	0.356	0.135	0.454	

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at $P<0.05$

TABLE 5

AVOIDANCE AND PREFERENCE SHOWN TO "WATER" AND "WATER+VILLAGE" AREAS BY CLAN 525

Area type	Exp. use.	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
"water"	224.66	248	0.655	0.669	0.777	*
"water+village"	118.30	95	0.345	0.223	0.331	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at P<0.05.

TABLE 6

AVOIDANCE AND PREFERENCE SHOWN TO "WATER" AND "WATER+VILLAGE" AREAS BY CLAN 462

Area type	Exp. use.	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
"water"	243.00	320	0.655	0.822	0.903	*
"water+village"	127.65	51	0.345	0.097	0.178	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at P<0.05.

TABLE 7

AVOIDANCE AND PREFERENCE SHOWN TO "WATER" AND "WATER+VILLAGE" AREAS BY BULL 464

Area type	Exp. use.	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
"water"	106.76	39	0.655	0.164	0.314	*
"water+village"	56.22	124	0.345	0.686	0.836	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at P<0.05.

TABLE 8

AVOIDANCE AND PREFERENCE SHOWN TO "WATER" AND "WATER+VILLAGE" AREAS BY BULL 450

Area type	Exp. use.	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
"water"	22.92	34	0.655	0.908	1.035	*
"water+village"	12.07	1	0.345	0.000	0.092	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at P<0.05

on it by one of us (AAD) in the years prior to radio collaring indicated that it did use this area earlier before radio collaring.

Tables 1 to 4 give the results of the test to determine the preference and avoidance shown by the study animals to the four different areas, namely water, water+village, village and other forest areas.

We tested to see the impact of human settlements on area within 2 km of water (an important resource for elephants) by testing just two classes, those areas < 2 km from water and > 1 km from a village, and those areas < 2 km water but < 1 km from a village i.e. "water" and "water+village" areas. This was necessary as villages are often in close proximity to water, which attracts elephants to the vicinity of such villages, and this leading to a bias in the results. Tables 5 to 8 give the results showing the preference and avoidance shown to areas under these two categories.

We also examined the impact of human settlement by testing the preference and avoidance shown to areas <1 km from human settlements and other areas > 1 km from human settlements irrespective of the presence of water in both the areas. Tables 9 to 12 give results of the four study animals.

TABLE 9

AVOIDANCE AND PREFERENCE SHOWN TO AREAS <1KM AND > 1KM FROM VILLAGE (HUMAN HABITATION) BY CLAN 525

Area type	Exp. use.	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
village < 1km	116.92	96	0.248	0.162	0.245	*
village > 1km	354.07	375	0.752	0.755	0.838	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at P<0.05.

TABLE 10

AVOIDANCE AND PREFERENCE SHOWN TO AREAS <1KM AND > 1KM FROM VILLAGE (HUMAN HABITATION) BY CLAN 462

Area type	Exp. use.	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
village < 1km	108.23	52	0.248	0.084	0.154	*
village > 1km	327.76	384	0.752	0.846	0.916	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at P<0.05

TABLE 11

AVOIDANCE AND PREFERENCE SHOWN TO AREAS <1KM AND > 1KM FROM VILLAGE (HUMAN HABITATION) BY BULL 464

Area type	Exp. use.	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
village < 1km	58.58	174	0.248	0.673	0.801	*
village > 1km	177.41	62	0.752	0.199	0.327	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at P<0.05.

TABLE 12

AVOIDANCE AND PREFERENCE SHOWN TO AREAS <1KM AND > 1KM FROM VILLAGE (HUMAN HABITATION) BY BULL 450

Area type	Exp. use.	Obs. use	EPU[1]	LCL[2]	UCL[3]	S[4]
village < 1km	12.66	2	0.248	0.000	0.100	*
village > 1km	38.34	49	0.752	0.900	1.022	*

[1]EPU = Expected proportion of use. [2]LCL = Lower Confidence Limit. [3]UCL = Upper Confidence Limit. [4]S = Significant at P<0.05.

DISCUSSION

The habitat in the study site can be divided into two main areas based on the criteria selected for this study, namely areas close to water (areas with water < 2 km away) and areas away from water (areas with water > 2 km away). Assuming that the vegetation in the two areas remains similar to a reasonable degree, we can expect variations in the area-use to be influenced by the availability of water.

Within these two areas a second variable, human settlements can be introduced. Here we assume that human impact will be most pronounced on the surrounding natural habitat within a distance of 1 km from the boundary of the settlement. This creates two additional areas from the original two, i.e. areas with water < 2 km and < or > 1 km from villages (i.e. "water" and "water+village" areas) and forest areas > 2 km from water and < or > 1 km from villages (i.e. "village" and "other forest areas"). It is important to note that most of the villages are located close to water sources as human beings are also very dependent on water. This creates a situation where the influence of human settlements are mostly present close to water, only 16% of the area within 1 km of a village was > 2 km from water while 84% was < 2 km from water, therefore human settlements affect areas closer to water more than they do areas away from water.

The importance of water for clans is evident from Tables 1 and 2, both the clans show significant preference to "water" areas while avoiding "other forest areas". This indicates the importance of water for clans. This is similar to the findings of several studies on African elephant (*Loxodonta africana*) which have shown that ranging is strongly influenced by water availability (Viljoen 1989, Western 1975, Williamson 1975). Most of these studies were carried out in semi-arid areas where water is fairly scarce. Though the importance of water and its influence on the ranging behaviour of the Asian elephant has been suggested by some authors it has not been substantiated by data. Given the abundant and closely spaced water sources in Asia, as compared to those of the African studies, it was important to determine the influence water has on the ranging behaviour of Asian elephants, especially in view of the importance of water for humans also and their tendency to locate their settlements close to water.

If elephants are significantly dependent on water then the management implication would be to look at the water distribution in conservation areas with a view to provide or facilitate the uniform distribution of water resources in the area. In the NBR which is dominated by deciduous forests water is patchily distributed and if the management objective is to maintain high elephant numbers it would be better to facilitate more uniform use of the available habitat rather than patchy use, with concentrations in patches and the resultant elephant impact on these patches. We would like to emphasize that increasing elephant numbers cannot be indefinitely supported by limited habitat irrespective of uniform or patchy use of habitat. We are only suggesting that higher numbers can be maintained with less impact on habitat if their use of the habitat is more uniform than patchy, by virtue of patchy water distribution.

In the case of bulls, bull 450 showed significant preference for "water" areas but used "other forest areas" in the expected proportion, showing neither avoidance nor preference (Table 4). But bull 464 showed significant avoidance to both "water" and "other forest areas" (Table 3). This does not show an overall avoidance to water as it showed strong preference for "water+village" areas (Table 3) indicating that water does play an important role in its range use strategy.

Considering the proximity of villages to water and the importance of water to elephants we can expect elephants to use some areas close to villages as they need water. This is seen in clan 525 which shows use of "water-village" areas at the expected proportion (Table 1) while bull 464 shows preference for such areas (Table 3). Clan 462 and bull 450 significantly avoided "water+village" areas (Tables 2 and 5 respectively). We further tested "water" and "water+village" areas separately to see if the study animals avoided them. Both the clans 525 and 462, and bull 450 significantly preferred "water" areas while avoiding "water+village" areas (Tables 5, 6 and 8 respectively), indicating that the presence of a village near water significantly reduced the use of that area. Bull 464 was just the opposite and significantly preferred to use "water+village" while avoiding "water" areas (Table 7). This bull was a chronic crop raider and was always present in the vicinity of villages. Whether the presence of the bull in this area was a result of its crop raiding habit or because its core home range incidentally happened to be located in that area is open to debate.

Since the presence of villages has a significant impact on the ranging behaviour of elephants, we tested to see if villages were avoided irrespective of the presence or absence of water in the habitat. As already mentioned villages are closely linked to water and this would, to some degree, bias the results in favour of elephants using areas around villages more than areas further away from water. Only 16% of the area around (< 1 km) villages was > 2 km from water while 47.3% of the area > 1 km from villages was > 2 km from water. Despite this bias we find that clans 525 and 462, and bull 450 used areas away from villages (> 1 km away) significantly more than areas close to villages (< 1 km away), indicating that areas around villages are avoided by elephants (Tables 9, 10 and 12).

Earlier studies (Balasubramanian *et al.* 1995) have shown that these two clans and bull 450 do not raid crops and that their home ranges are to a large extent intact. We can, therefore, reasonably conclude that clans and bulls whose home ranges have not been disrupted significantly and whose ranging and behaviour remains normal will avoid using areas around human settlements. Human settlements and activity within the elephants' habitat has a detrimental impact on elephants directly by rendering the surrounding habitat unusable to elephants. Considering that the area of human influence (< 1 km from a village) in the present study site is 24.8% of the area, it represents a significantly large part of the habitat being unavailable to normally ranging elephants. This loss is even more significant if we consider that nearly 84% of this area is < 2 km from water, an area highly preferred by elephants. So human settlements not only deny the use of significantly large areas they also deny the use of significantly important (preferred) areas for elephants.

Only bull 464 showed a significant preference to areas < 1 km from villages while avoiding areas > 1 km from villages. As already mentioned, this bull was a regular crop raider and whether its use of such areas was a function of its core home range being in such areas or because of its raiding behaviour is debatable. To say the least, this bull came into regular conflict with humans and was shot at, as are most chronic crop raiders and frequently injured, resulting in the bull not coming into musth in the two years of study. This would translate into loss of reproductive success at a time when the bull was supposed to be in its prime breeding phase of life.

The results do not support the hypothesis "Clans and bull use areas with and without human disturbances equally". Overall two clans and one bull avoided areas < 1 km from human settlement even when such areas were within 2 km from a water source, an area preferred by all study animals. Only bull 464 showed a preference to areas close to human settlement, but whether its use of such areas was a function of it core home range being in such areas or because of its raiding behaviour is debatable.

Conclusions and recommendations

1. The availability of water is a major factor in the elephants' strategy of range use. Clans and bulls with normal (not man modified) home ranges significantly prefer areas closer to water than away from water. This can be interpreted as, water governs elephant distribution and range utilization.

Water, especially in the deciduous forests is patchily available and this results in patchy use of habitat by elephants. The elephants impact on vegetation is therefore uneven over the protected area. If elephant populations in protected areas are to be maintained at high levels then it is better to ensure that the elephants' utilization of the habitat (and resultant impact) is more uniform. One waterhole in a forage rich, water deficient, low use area is more useful than ten waterholes in an existing high use area (Desai 1995).

2. Human settlements have a dual impact on elephant habitat. The directly visible and measurable one is that of habitat loss through conversion of elephant habitat for human use. The second which is equally, if not more, harmful but rarely visible is that of area denial. Human influence and impact on elephant habitat extends well beyond the boundary of human use areas (village and agriculture) into the

surrounding elephant habitat. Normally ranging clans and bulls significantly avoided areas close to human settlements, resulting in vast areas being denied to the elephants

In addition, human settlements are almost always in close proximity to water sources as humans are also dependent on water. As already mentioned areas close to water are the preferred areas for elephants, loss of such areas has much more serious impact on elephants than areas away from water. Thus human settlements not only deprive the elephants of the use of significantly large areas of habitat but also deprive them of significantly preferred habitat.

Managers should try and ensure that new settlements are not allowed within or adjoining protected areas as the actual detrimental impact of the settlement extends well beyond the settlement's boundary. If new settlements are a must (tribal resettlement, etc.) then these should be attached to existing human use areas rather than creating new enclaves which would have the problem of larger perimeters and therefore area of influence, and at the same time create problems in new areas. It should also be remembered that the growing human population and development of existing settlements will also result in the expansion of the area of influence of these settlements, as human impact will extend from the settlement with increasing demand for resources from the natural habitat.

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NEW DESCRIPTIONS

A NEW SPECIES OF *PUERARIA* DC. (FABACEAE) FROM GARHWAL HIMALAYA, U.P., INDIA[1]

(*With fifteen text-figures*)

L.R. Dangwal and D.S. Rawat[2]

During the course of botanical explorations in the remote localities of the Garhwal Himalaya we came across some interesting specimens of the genus *Pueraria* DC. The specimens were matched with *Pueraria ferruginea* Kurz. However, thorough perusal of literature and examination of the specimens at the Botanical Survey of India, Northern Circle (BSD) and Forest Research Institute (DD), Dehradun, indicated that it is a distinct species, and is described as a new species.

Pueraria garhwalensis sp. nov.

Haec species *Pueraria ferrugineae* Kurz affinis, sed differt plantae habitu annuo, foliis glandulari-pubescentibus, in superficiebus ambabus, stipulis majoribus, calycis lobis inaequalibus, quam tubo brevioribus, corollae ala carinaque membranacea, staminibus diadelphis, stamine uno vexillari connato ad basin columnae, antheris inaequalibus; leguminibus adpresse glandulari-pubescentibus, cum bracteis persistentibus.

Herbae volubiles, *ca* 1 m altae, cum pilis adpressis glandularibus, rami orientes ex axillis foliorum. Folia pinnatim trifoliata, *ca* 13 cm longa (petiolo incluso), foliola 3 - 6 x 1.6 - 5.2 cm, foliola terminalia late ovata, aequilateralia, acuminata, chartacea, utrimque glandulari-pubescentia; nervi alterni, in 2-3 paribus; stipulae magnae, lanceolatae, 7 mm longae. Inflorescentiae racemosae, axillares vel terminales, fasciculatae, binatae vel ternatae. Flores emergentes cum foliis. Flores *ca* 7 mm longi cum bracteis persistentibus; bracteae lanceolatae, *ca* 6 mm longae, utrimque glandulari-pilosae. Pedicellus *ca* 4 mm longus. Calyx campanulatus, *ca* 5 mm longus, tubus dentibus longior, dentes 5-lobati, inaequales, 2 breviores, 3 longiores. Corolla cyaneo-purpurea; vexillum obovatum, 7 mm longum, alae breviter angustae, membranaceae, *ca* 7 mm longae; carina breviter membranacea, *ca* 7 mm longa. Stamina diadelpha (9+1), stamen uno vexillare connatum ad basin columnae; antherae inaequales. Carpellum *ca* 7 mm longum; ovarium minute pilosum, stipitatum, stylus brevis, curvatus, stigma capitatum. Legumina linearia, adpresse glandulari-pilosa, *ca* 3.0 x 0.3 cm, cum bracteis persistentibus et staminis. Semina 1 - 4 in legumine, ca 2 mm longa lataque.

Typus: Agunda, Tehri District, Garhwal Himalayas, Uttar Pradesh, 1300 m, 25.9.1993, L.R. Dangwal, 12,363 A, (Holotypus - GUH); Ibid. L.R. Dangwal, 12,363 B (Isotypus-GUH).

Pueraria garhwalensis sp. nov.
(Fig. A - J2)

The new species is closely allied to *Pueraria ferruginea* Kurz from which it differs in the following characters.

This taxon is allied to *Pueraria ferruginea* Kurz, however, it differs by its annual habit, leaves having glandular pubescence on both the surfaces; stipules large; calyx lobes unequal, shorter than tube; corolla wing and keel feathery; stamens diadelphous, vexillary one fused at the base of column; anthers unequal; pods glandular-adpressed hairy, with persistent bracts.

Annual, twining herbs, *c* 1 m tall, with glandular adpressed hairs, branches arising from the axils of the leaves. Leaves pinnately trifoliate, *c* 13 cm long (including petiole); leaflets 3 - 6 x 1.6 - 5.2 cm, the terminal leaflets broadly ovate, equal sided, acuminate, chartaceous, furnished with glandular hairs on both the sides; nerves alternate, 2 - 3 pairs; stipules large,

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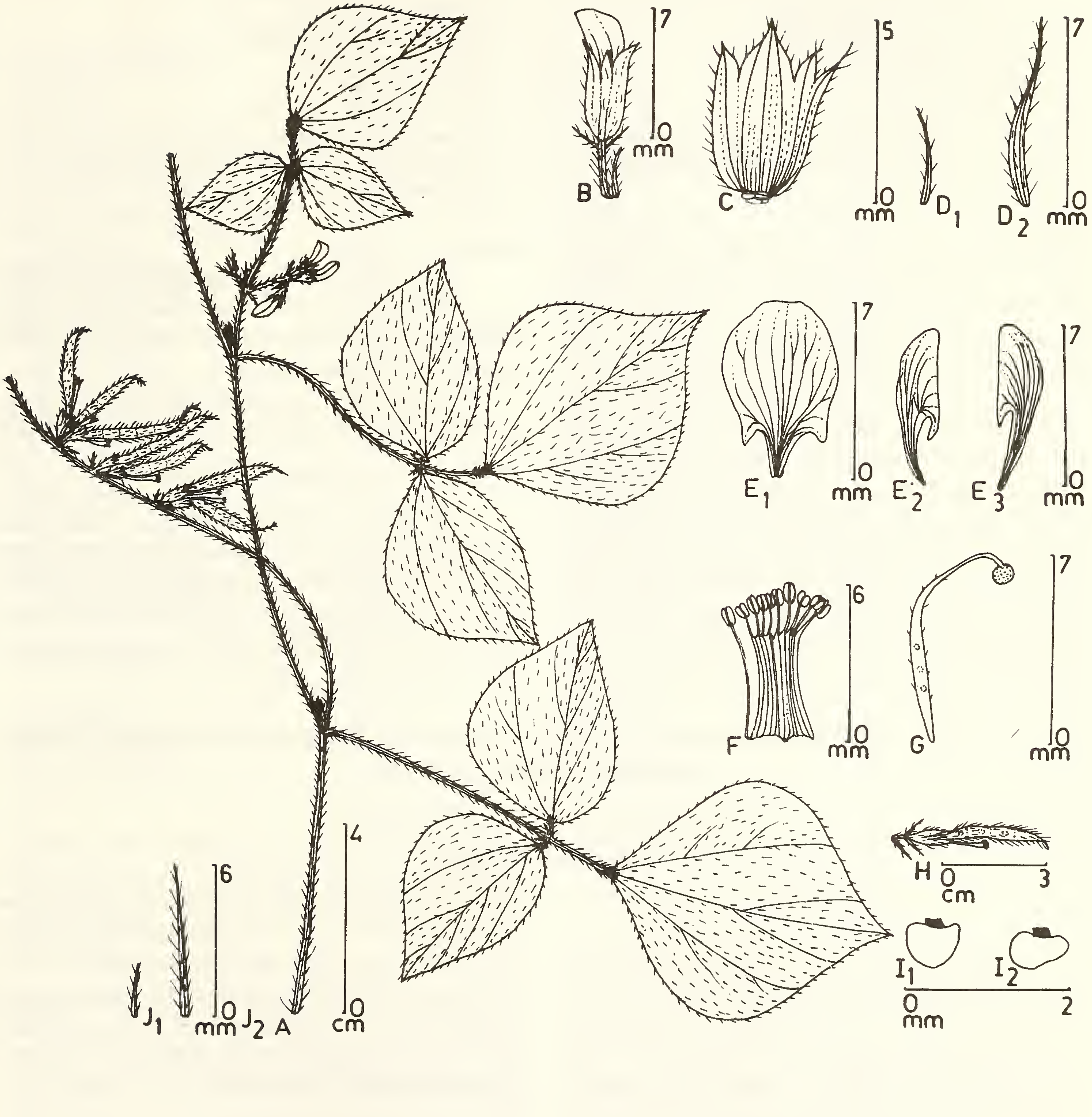
B
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3
cm
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Figs A - J_2 *Pueraria garhwalensis* sp. nov.: A. Flowering and fruiting branch; B. Flower; C. Calyx; D_1 - D_2. Bracts; E_1 - E_2 - E_3. Corolla; F. Stamens; G. Carpel; H. Pod with persistent bracts and stamens; I_1- I_2. Seeds; J_1 - J_2. Stipules.

KEY FOR THE TWO SPECIES

Pueraria garhwalensis sp. nov.	*Pueraria ferruginea* Kurz
1. Annual glandular-hairy herbs.	Perennial hirsute herbs.
2. Stipules large, *ca* 7 mm long.	Stipules small, *ca* 3 mm long
3. Leaflets sparsely hairy.	Leaflets densely hairy.
4. Bracts persistent.	Bracts caducous.
5. Calyx large, *ca* 5 mm	Calyx small, *ca* 2.5 mm long.
6. Stamens diadelphous (9+1); anthers not uniform.	Stamens monoadelphous; anthers uniform.
7. Pods narrow 3 mm broad, glandular hairy with persistent bracts and stamens.	Pods broader, 5-6 mm, sparsely hairy, without persistent bracts and stamens.

lanceolate, 7 mm long. Inflorescence axillary or terminal, fasciculate, 2- 3 nate, racemes. Flowers emerge with leaves; flowers *c* 7 mm long, with persistent bracts; bracts lanceolate, *c* 6 mm long, glandular hairy on both the sides. Pedicel *c* 4 mm long. Calyx campanulate, *c* 5 mm long, tube longer than teeth; teeth 5-lobed, unequal, 2 smaller, 3 larger. Corolla bluish-purple; vexillum ovate, 7 mm long; wing shortly narrow, feathery, *c* 7 mm long; keel shortly feathery, *c* 7 mm long. Stamens diadelphous (9+1), vexillary one fused at the base of column; anthers unequal. Carpel *c* 7 mm long; ovary minutely hairy, stipitate; style short, curved; stigma capitate. Pods linear, adpressed glandular hairy, *ca* 3.0 x 0.3 cm, with persistent bracts and stamens. Seeds 1 - 4 in a pod, *c* 2 mm long as well as broad.

Flowering and Fruiting: August - November.

Ecology: In moist and shady places along roadsides on slopes, associated with *Carrisa opaca*, *Berberis* and *Rubus* species.

Etymology: The species is named after the locality of Garhwal Himalaya, in Uttar Pradesh, India.

ACKNOWLEDGEMENT

We thank Dr. N.C. Majumdar, Ex-Scientist 'SE' Botanical Survey of India, Calcutta for the latin diagnosis of the taxon and the authorities of Botanical Survey of India, Northern Circle (BSD), and Forest Research Institute (DD) Dehra Dun for permitting us to consult their herbaria.

2. *GARRA SURENDRANATHANII* - A NEW CYPRINID FISH FROM THE SOUTHERN WESTERN GHATS, INDIA[1]

C.P. SHAJI, L.K. ARUN AND P.S. EASA[2]

(*With one text-figure*)

INTRODUCTION

Nineteen species of *Garra* have been described from the Indian subcontinent. Of these, five are distributed in the state of Kerala. These are *Garra mullya* (Sykes), *G. gotyla stenorhynchus* (Jerdon), *G. mcClellandi* (Jerdon), *G. hughi* Silas and *G. menoni* Remadevi and Indra (Jayaram, 1981; Talwar and Jhingran, 1991). *G. menoni* (Remadevi and Indra, 1986) described from the Kunthi river of Silent Valley, Kerala was later synonymised with *G. mullya* by Talwar and Jhingran (1991) without any discussion. But Menon (pers. comm.) considers it as a valid species. A new species of *Garra*, collected recently from three river systems of Kerala originating from Western Ghats is described

STUDY AREAS

(i) Chalakkudy river flows through the central portion of Kerala. The collection location of the stream (76° 41' E and 10° 22' N) is narrow (15m),

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MORPHOMETRIC MEASUREMENTS OF *Garra surendranathanii* SP. NOV.

	Holotype	Paratypes		
		Range	Mean	SD
% Standard Length				
Total length	117.27	116.66-119.87	118.14	1.61
Head length	19.87	18.25-21.98	20.20	1.52
Snout length	8.42	9.12-11.18	9.85	0.94
Eye diameter	5.55	4.93-5.59	5.35	0.30
Inter orbital width	7.93	7.45-8.37	7.84	0.38
Depth of body at dorsal origin	15.87	12.65-16.23	14.80	1.57
Depth of body at anal origin	12.56	12.11-12.69	12.38	0.23
Pre-dorsal distance	40.83	38.49-42.87	40.89	1.80
Pre-pectoral distance	20.94	15.27-20.94	18.03	2.31
Pre-anal distance	72.25	72.22-73.14	72.57	0.36
Pre-ventral distance	46.27	44.44-47.64	46.33	1.36
Length of dorsal fin	21.98	17.50-22.36	20.48	2.13
Length of ventral fin	17.39	17.27-18.25	17.90	0.45
Length of anal fin	17.27	16.04-17.39	16.69	0.55
Length of pectoral fin	19.84	18.63-22.51	20.29	1.63
Basal width of dorsal fin	14.28	13.36-14.31	13.72	0.41
Basal width of ventral fin	5.55	4.96-5.55	5.35	0.27
Basal width of anal fin	7.14	6.28-7.41	6.92	0.47
Basal width of pectoral fin	6.83	6.28-7.09	6.70	0.33
Depth of caudal peduncle	9.92	9.31-10.49	9.01	0.48
Length of caudal peduncle	21.42	17.80-22.04	20.07	1.74
% Head Length				
Eye diameter	28.12	22.72-30.43	25.65	3.40
Snout length	42.85	42.87-50.00	46.10	2.74
Inter-orbital width	38.09	37.50-43.47	39.61	2.73
Width of mental disc	28.57	28.57-36.66	33.33	3.45

shallow (20cm) and slow flowing, at an altitude of 483 m above msl. The major substrates were pebbles and boulders. The stream is surrounded by moist deciduous forests.

(ii) Periyar is one of the major river systems in Kerala. The collection was made from a site in a regulated stream between two dam reaches (Mullaperiyar and Idukki) at Ayyppankovil (77° 02' E and 9° 43' N) at an altitude of 720 m above msl. The stream is a slow flowing perennial system and has large boulders and bedrocks. The area is highly disturbed by human activities and agricultural plantations.

(iii) Pamba river at Mookkampetty is a relatively fast flowing tributary in Azhutha (76° 56' E and 9° 26' N), at 160 m above msl. The substrates were mainly bedrock and sand.

Description: D = 2/8; P = 1/11-12; V=1/6; A=2/5; L = 35-36.

The morphometric measurements are presented in Table 1.

The body is very elongated and depth of the body at dorsal origin is 12.5-16.23% in SL (mean = 15.87). Head with moderate length and is 18.25-21.95% in SL (mean=20.03). Snout about 50% in HL and with many tubercles. No deep transverse groove at the tip of the snout as in *G. mcClellandi* (Jerdon) (Fig. 1). Inter orbital region flat. Barbels

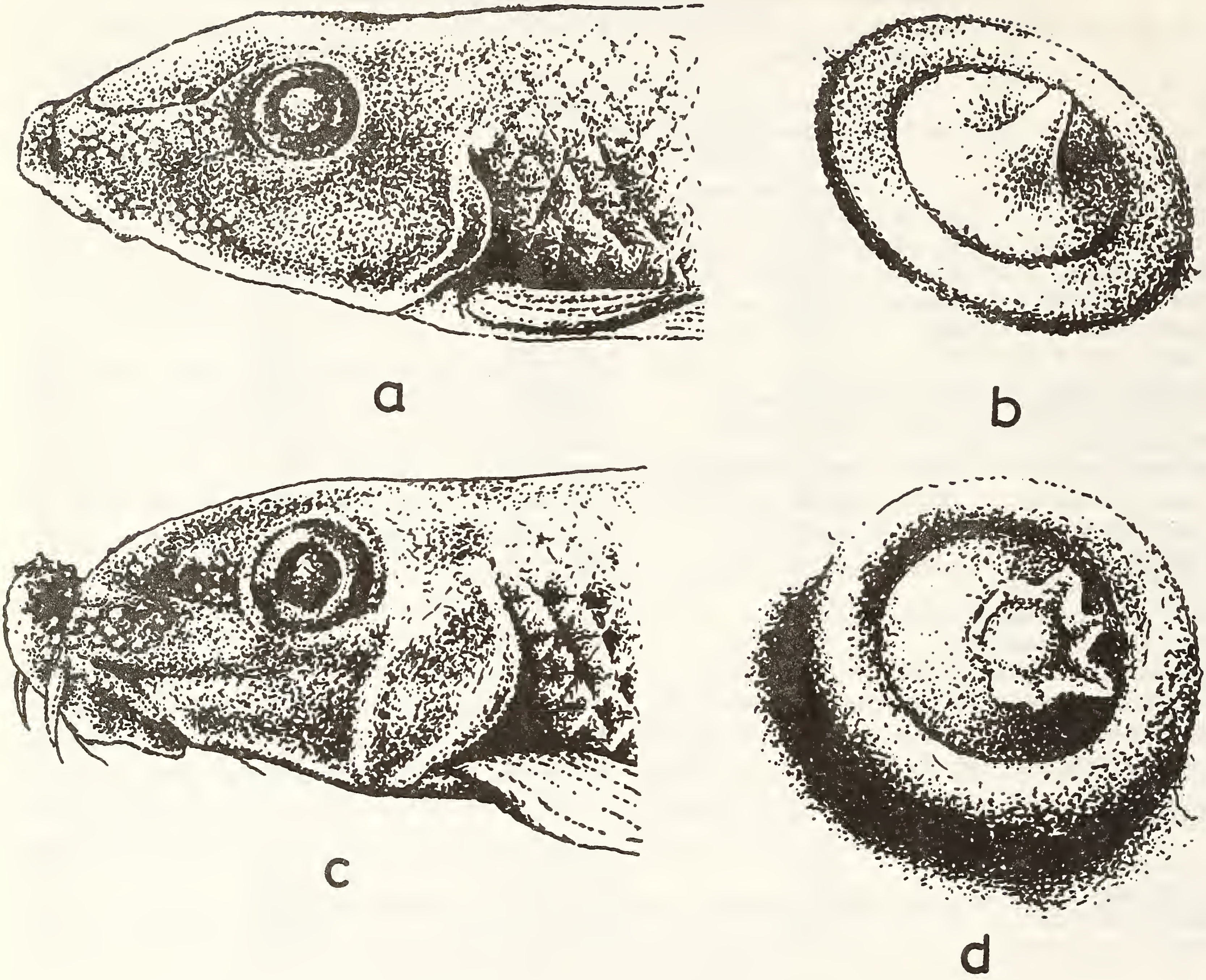

Fig. 1. a. *Garra surendranathinii* - A view of the head region; b. A spinate tubercle - enlarged; c. *Garra mcClellandi* - A view of the head region; d. Rosette-shaped tubercle

two pairs, rostral and maxillaries. Rostral longer than the maxillaries, the latter being placed in the labial groove and not so conspicuous. Mental disc well developed and its width 6.28-7.14% in SL (mean = 6.94). Dorsal fin inserted nearer to the tip of the snout than the base of the caudal fin and anterior to the pelvic fin. The branched rays of the dorsal fin have a series of dark spots which are not easily distinguishable. Vent situated nearer to anal fin origin, the distance from vent to anal fin is 43.93-46.06% (mean = 45.33) in the interdistance between ventral fin and anal fin origin. The anterior portion of the breast is devoid of scales; belly with cutaneous scales.

The new species has the majority of tubercles with smooth surface and a few with a horn-shaped spine (Fig. 1 a & b). The other species of *Garra* (*G. gotyla stenorhynchus* and *G. mullya*), have horn-shaped spines. In *G. mcClellandi*, the spines are rosette-shaped (Fig. 1 c & d). *G. hughi* has not been examined for nature of tubercles for want of specimens. G. *menoni*, though synonymised with *G. mullya*, is reported to have no tubercles.

Coloration: Dorsum brownish-black and belly white. The scales have black edges. Due to this, the body appears to have many bands along the lateral side. Head with many black dots and reticulations. Fins are purple in colour at their bases with tips marked orange. A black dot is present on the upper angle of the gill opening.

Etymology: It is the latinised form of the name Shri. P.K. Surendranathan Asari, Chief Conservator of Forests, Kerala Forest Department, who has been a constant source of encouragement to Wildlife research activities in the state.

Holotype: F/124/KFRI. 147.00 mm SL collected from Orukomban, tributary of Chalakkudy river on 12-03-1996 by the authors. The specimen is presently deposited in Western Ghat Regional Station of the Zoological Survey of India at Calicut (No. WGRS/ZSI/9390).

Paratypes: F/122/KFRI, F/123/KFRI, F/145/KFRI (95.5 - 161.0 mm SL) collected from Orukomban, Chalakkudy river by the authors on 12.iii.96. The specimen, F/123/KFRI is also deposited in Western Ghat Regional Station in the same lot (WGRS/ZSI/9390).

F/269/KFRI 132.0 mm SL was collected from Ayyppankovil in Periyar river on 21.iii.96 by us.

F/270/KFRI 152.5 mm SL was collected at Mookkampetty of Azhutha tributary of Pamba river on 22.iii.96 by us.

Remarks: The new species comes under the Yunnanensis complex (Menon, 1964) and shows great resemblance to *G. mcClellandi* (Jerdon) in body form, position of the dorsal fin and number of lateral line scales. But it can be distinguished by the nature of the spine in the tubercles and the absence of the deep transverse groove in the snout. It differs from *G. kempi* Hora by large scales, position of the dorsal fin and less number of lateral line scales. *G. mullya* (Sykes) and *G. menoni* (Remadevi and Indra) differ from it by the number of lateral line scales and *G. gotyla stenorhynchus* (Jerdon) by absence of proboscis. *G. hughi* (Silas) lacks scales in the mid-dorsal region.

ACKNOWLEDGEMENT

We are grateful to Dr. A.G.K. Menon for reviewing the paper. The study was supported by the Kerala Forest Department (Wildlife wing).

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THE GENUS *MACROCHELES* LATREILLE (ACARINA: MACROCHELIDAE) IN INDIA. A NEW SPECIES ASSOCIATED WITH DUNG BEETLE (COLEOPTERA: SCARABAEIDAE) FROM MADHYA PRADESH[1]

RANJIT KUMAR ROY[2]

(*With four text-figures*)

A new species of *Macrocheles* (Latreille) namely *bucephali*, associated with *Heliocopris bucephalus* (F.) is described from Jabalpur, Madhya Pradesh.

INTRODUCTION

Through the courtesy of Dr. Y.N. Gupta, Central Regional Station, Zoological Survey of India, Jabalpur, a number of *Heliocopris bucephalus* (F.), all collected in Jabalpur, were received during an investigation on the systematics of macrochelid mites. Four females, lodged deep into the coxae, were recovered from one of the beetles. The material recovered proved to be females of a new species of the genus *Macrocheles* Latr. This is the first report of the genus from Madhya Pradesh.

Types have been deposited in the Zoological Survey of India, Calcutta. Measurements given in the text are in micrometres.

Macrocheles bucephali sp. nov.

FEMALE (Figs. 1-4): Dorsal shield (Fig. 1) 727-780 long, 379-424 wide, granulated and bearing 28 pairs of setae. Setae j_1 and j_4 plumose distally, remainder simple and pointed.

Sternal shield as broad as long and ornamented with punctate *liniae, l.m.t.* distinct, other *liniae* as illustrated (Fig. 2); sternal setae simple and pointed. Genital shield truncated posteriorly and ornamented with punctures; genital setae simple and pointed. Ventrianal shield 227-242 long, 227-242 wide, ornamented with punctate lines; ventrianal setae simple.

Gnathosoma with six rows of deutosternal denticles. Tectum not discernible. Movable digit of chelicera (Fig. 3) unidentate; fixed digit tridentate; cheliceral dorsal seta thickened and serrated; cheliceral brush more than half the length of movable digit.

Approximate lengths of legs (excluding pretarsi): I-400; II-333; III-303; IV-394. Tarsus I (60) longer than Tibia I (45). Tarsus II (Fig. 4) 90, Tibia II (75). Chaetotaxy of legs and palpi normal, genu of leg IV with six simple setae.

MALE: Unknown.

Material examined: Holotype: FEMALE, INDIA: Madhya Pradesh: Jabalpur, ex *Heliocopris bucephalus* (F.), 6. iv. 1985, Y.N. Gupta coll.; Paratypes: 3 females, same data as for holotype.

Remarks: *M. bucephali* sp. nov. seems to be related to *M. uroxys* Krantz. The ornamentation of the sternal shield (disposition of *l.m.t.* and *l. arc.*) in both the species is similar. But the former can be easily separated from the latter in the nature of dorsal chaetotaxy. Dorsal setae simple in *bucephali* except j_1 and j_4 with distal plumosity, while most of the dorsal setae are plumose in *uroxys.* Interestingly *uroxys* is also a phoretic member of *Macrocheles* described by Krantz (1983) found on sloth (*Bradypus tridactylus* L.) associated scarab beetles (*Uroxys besti* Ratcliffe) from Brazil. According to Ratcliffe (1980), sloth (arboreal edentates) - associated scarabs utilise the sloth for shelter and dispersal, and feeding on sloth dung.

ACKNOWLEDGEMENT

The kind courtesy of Dr. Y.N. Gupta, Central Regional Station, ZSI, Jabalpur in providing me with the coleopteran material is gratefully acknowledged.

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This is the eighth paper in the series — "Studies on Indian Macrocheles."

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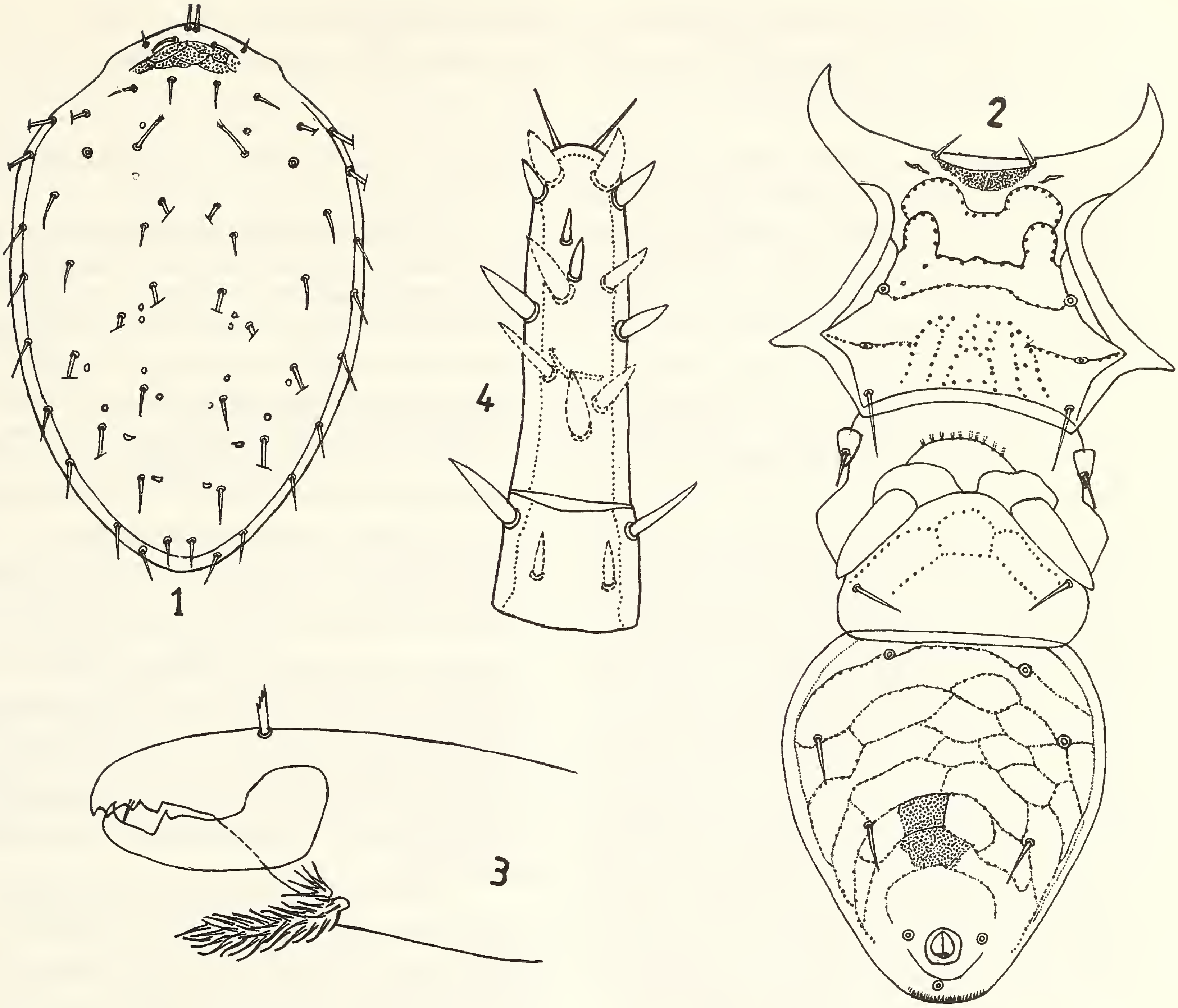

Fig. 1-4. Dorsal shield; 2. Venter; 3. Chelicera; 4. Tarsus II

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* not seen in original.

REVIEWS

1. FENCING THE FOREST. By Mahesh Rangarajan. pp. xii + 245 (21.5 x 14 cm), with three maps. New Delhi, 1996. Oxford University Press. Price Rs. 395/-

In "Fencing the Forest" Mahesh Rangarajan takes an even handed look at the history of the State's involvement in the protection or to express it more precisely the management of forests. His case study area is the former Central Provinces, presently Madhya Pradesh, which State perhaps still has the largest area under forest cover in the country.

Who should look after the forests is the question and as Rangarajan says "There is little to suggest that there was an ecological equilibrium in pre-British India" and in one of the oldest agrarian civilisations in the world only the sacred groves showed some restraint on the customary use of trees and the consequent degradation. However, even at the beginning of British interest in forests there was a school of thought as advocated by Thomas Munro of the Madras establishment who argued for a minimal role for government in forest management and had faith in the ability of peasants and landowners to act in their own long-term interest. But as in the present day, greed had no restraint and the habit of selling their birthright to the traders, which is so evident presently in the state of Arunachal Pradesh, was equally conspicuous in the past and State restraint had to be reimposed to protect the teak forests of Malabar from complete denudation.

Even at that point of time conservation was a subject for debate, the scientists of the East India Company pointed to the connection between deforestation and drought and particularly to the disastrous effects of *Kumri* or shifting cultivation in the Western Ghats. However, where imperial interests were concerned, forests were destroyed without compunction as, for example, the forests of Punjab and Shikargarh forest of Sind. Imperial interests were the main reason for the early intervention in forest management. A mile of rail track for instance required 1800 to 2000 sleepers, and in Betul district alone 200,000 logs were felled for the railways, 100,000 trees were felled for the Jabalpur section and 400,000 sleepers were provided for the Satpura railways.

In the first three chapters, Rangarajan looks at the historic background of forest in relation to man in his study area in the historic context. The compulsion to clear fell was not only for settled agriculture and therefore a peaceful community, but also to prevent the providing of shelter to the landless and the forest dwellers who were a constant menace to the settled agricultural community. To the British the forests were an exploitable and sustainable wealth and therefore to be protected. The forest act of 1878 brought 20% of the forests of the Central Provinces under government control as reserve forest. In the process, the tribals, the Gonds and the Baigas were the losers particularly the Baigas, to whom *bewar* cultivation, where land was clear felled, burned and then sowed was a way of life and central to their identity. To use the plough on mother earth was a sacrilege and among the tribals, the Baigas were the main losers in the suppression of slash and burn cultivation.

The fourth chapter looks at shikar and the Raj. The British came with a tradition of extermination of the larger and dangerous predator species. They had exterminated the wolf in Britain and to them tigers were the equivalent of thugs and dacoits from the ravages that man-eaters caused. In three years between 1866-69 bounty was paid on over 1500 tigers. But this early interest in wiping out the predator fauna gave way to a more rational approach when it was realised that killing off a predator increased herbivore damage to cultivation. Another factor which moderated this pressure on predators was the concept of sport hunting available only to the elite in Britain which became open to all in India. Clubs exclusive to Europeans transferred the exclusiveness to India and made it available to those who were not acceptable in their own country. In turn Indians and Indian methods of hunting were looked down upon and discouraged and the reserve forest became the closed hunting grounds of the British with the forest officials becoming somewhat recalcitrant game keepers. The Maharajas in their turn aped the British and retained forests for their shikar and in turn denied access to all except at their own will and pleasure.

Rangarajan concludes that the "Fencing of the forest" by the Forest Department caused a major revolution in styles of land management and the remaking of the forest was even extended to the natural world, with systematic combine of extermination and "the pattern of settlement and agricultural production and the distribution of fauna all changed in new ways in a very short span of time."

A very readable account of the ecological, social and economic changes that were effected by the organisation of a monolithic forest department with a limited vision of commercial production.

J.C. DANIEL

2. CHANGING PERSPECTIVE OF BIODIVERSITY STATUS IN THE HIMALAYA. pp. 1-187, Plates in colour. British Council Division, New Delhi. Price Rs. 400/-

In this book sponsored by the British Council and edited by G. S. Gujral and V. Sharma, several authors look at the biodiversity of the Himalayas from their own perspective.

Biodiversity has now become the conservation catchword as ecology was some years ago. Biodiversity can be looked at from different perspectives and in this book the authors present their case for the preservation of the biodiversity of the Himalayas from their point of view. The book has been organised into six sections, the last section being exclusively confined to photographs of the Himalayas.

An executive introduction by the editors introduces the subject and focuses on the objective which is to review the status of biodiversity in the Himalayas.

The introductory chapter precisely states what ails biodiversity in the Himalayas and elsewhere in the Indian sub-continent when it states that the human population "has increased manifold from 18 million in 1951 to 33 million in 1981" an 81% increase in 30 years and the resulting demand on natural resources makes one wonder whether there is any possibility of sustainable use of natural resources as has been advocated in this book and elsewhere. The available resources cannot accept the pressure on them from the increased human population.

The chapter on current status of Biodiversity in the Himalayas, discusses the status of flora, fauna, wetlands, crops, livestock and includes a case study on Bamboo. About 40% of the Himalayan flora is endemic, and the flora generally is rich. The Himalaya is a centre of floral diversity but biotic interference has taken its toll and several species have either disappeared or have become dangerously threatened. The case study on the bamboo, for instance, establishes that the high altitude alpine bamboos, an important source of food for wildlife, and equally important for erosion prevention of a fragile environment are under heavy grazing pressure. The Himalayan fauna which has both palaearctic and a rich Indomalayan component with many species adapted for life at high altitudes presents an equally gloomy picture. In the listing of species there seems to be some confusion on the limits of distribution of the Himalayan fauna as some typically plain species are included. About 160 species of crop plants are reported to have originated in the Himalayas and efforts are being made to save the germplasm by Indian Institutions but the need seems to be *in situ* conservation which requires "Conservation farms" for long-term conservation and protection of germplasm in the field. Himalayan wetlands, especially those of the arid highlands of Ladakh and the wetlands of the Kashmir valley, are of high biodiversity interest and call for attention.

Can there be sustainable development considering the enormous population pressure on existing resources and the stress on indigenous cultures from the inroads towards uniformity in living standards introduced by better communications towards a one world standard. The authors in the section on economic concepts believe so but their arguments are not very convincing. Take for instance the jhuming cycle which has come down through population pressure to less than 5 years, leading in some cases to annual cropping. Biodiversity is hardly likely to survive under such conditions. The sacred groves, repositories of biodiversity, are either being degraded or disappearing. Degraded ecosystems make up 20% of the total geographical area of the Himalayas and water management remains a key to ecosystem rehabilitation. The case studies presented in this chapter are a record of the losing battle against disappearance of life styles and the regional biodiversity which supported them.

The chapter concludes with methods of biodiversity conservation, what has been done and what needs to be done. There is an urgency for protection which continues to be smothered in apathy and inaction.

The final section of text considers policy and management issues and how to prevent the nation's natural wealth from being sold down the river. The manner in which the biodiversity wealth of the Himalaya can be monitored and managed are discussed. The methods of monitoring are concisely described. Also how best to protect Himalayan Biodiversity, particularly medicinal plants, from the multinational pirates on the prowl. The answer seems to be, in these days of GATT and patent laws, to cover the nation's biodiversity wealth with a legislative blanket of laws enforcing national sovereignty.

The British Council, the editors, and the authors are to be congratulated on producing a thought provoking volume.

J.C. DANIEL

MISCELLANEOUS NOTES

1. GREY MUSK SHREW (*SUNCUS MURINUS*) FEEDING ON TOAD

In December, during a visit to the Lonar crater, near Mehekar in Buldana district, Maharashtra, I heard the familiar squeak of the Grey Musk Shrew (*Suncus murinus*) at night. I located it and to my amazement, saw it had caught a big live toad (*Bufo* sp.) and was dragging it towards a hole. It finally managed to drag the toad into the hole.

About 15-20 days later, in Pune, I started finding live helpless Common Toads in my house. Their thigh muscles had been eaten up, and the bones exposed. The toads were, however, still alive. I was desperately trying to find out what was going on, and one night I did. It was again a Grey Musk Shrew. I actually saw it chasing a toad, which it grabbed with its sharp teeth, and completely chewed and ate the flesh of the thighs upto the bones and then left the toad which was still alive.

Are the parotoid glands ineffective as a defence against shrews? And why did the shrews leave the toads without eating them completely? I have not seen this occurrence since that day.

January 13, 1996 KRUSHNAMEGH J. KUNTE

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2. ON THE OCCURRENCE OF THE INDIAN TREE SHREW (*ANATHANA ELLIOTI*) IN THE GARHWA FOREST, BIHAR

In the summer of 1994 during an inspection of forests of Ranka range, in Garhwa forest, in south-west Bihar, I saw an animal, which was almost like a squirrel but without the stripes.

The area where this animal was found lies in the newly created Garhwa district, carved out of the old Palamau district. The southeastern part of the Garhwa district forms a part of the Palamau Tiger Reserve. The forests of Garhwa where the animal was seen is of Type II, Group 5D/SI or Northern dry tropical forests according to Champion and Seth's classification.

The villages, where I have spotted this animal are Serasham, Hurdag, in Ranka block and village Ramgarh in Chainpur Block. After the winter of 1994, when vegetation in Ranka Range forest started getting dry, I could sight this animal a number of times. Some villagers also confirmed the description of the animal, and said that they called it "Ban rukhi" which means "Wild Squirrel."

One specimen was caught in April 1995. By appearance it resembled a five-striped ground squirrel, except for its uniform brown (rat like) colour. Its dentition was also quite different, which distinguished it from the rodent. It was identified as the tree shrew.

The specimen caught measured 20 cm. in body length, and tail was 18 cm.

Brander (1923) states that the Madras Tree shrew (*Tupaia ellioti*) was found throughout the Central Province (presently parts of Madhya Pradesh and Maharashtra) that included Surguja district, in Madhya Pradesh that adjoins Garhwa.

There is no mention of this species in the working plan (1974-2004) of Garhwa South Forest Division. The working plan of 1964-74 mentions the grey musk shrew (*Suncus murinus*). However, D.G.E. Sunders' final report on the survey and settlement of the Palamau in 1898 reported an animal similar to the Madras Tree Shrew.

The discovery of *Anathana ellioti* confirms the occurrence of this species in south-west Bihar.

June 10, 1996 H.S. GUPTA

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3. SIGHTING OF RATEL (*MELLIVORA CAPENSIS*) IN SIDHI DIST. OF MADHYA PRADESH

The occurrence of the Ratel (*Mellivora capensis*) in Morena District in north Madhya Pradesh have been mentioned in the *Journal* (Rajiv Saxena, *JBNHS 92 (3)*: 410).

Way back in the early eighties, three animals were seen by me during an evening drive in the Barnawapara Sanctuary of Raipur District. On 5 April, 1993 while returning from Shahdol to Sidhi, around 2040 hours, a Ratel was seen on the edge of a culvert, on a small nallah of the river Banas. The location was hardly 100 m from the river. The Ratel was searching for food around the culvert and on the approach of our jeep, it turned and dashed away towards the forest adjacent to the river. The location of the sighting is the northeastern part of Madhya Pradesh and confirms its occurrence in that part of the State.

August 7, 1996

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4. SIGHTING OF TWO CAT SPECIES (*FELIS* SP.) FROM THE WESTERN GHATS, SOUTH INDIA

Two species of cats, the Leopard Cat (*Felis bengalensis* Kerr) and the Rustyspotted Cat (*Felis rubiginosa* Geoffroy), were recently collected from the Western Ghats in South India. The Leopard Cat was obtained from the Peppara Wildlife Sanctuary in the southwest end of the Western Ghats in Trivandrum District, Kerala (76° 40' N-77° 17' N and 8° 7' E-8° 53' E; altitude 197 m to 1,373 m). The vegetation consists of moist deciduous, semi-evergreen and evergreen forests.

During studies on crop damage by wild animals in the Kani tribal settlements, a specimen of the Leopard Cat was brought to us on 1st July, 1994. The cat was killed with a spear made of bamboo. The body measurements were; total length 85 cm; length from neck to tail 37 cm; length of tail 30 cm; snout to neck 18 cm; length of fore limb 26 cm, length of hind limb 30 cm. Weight was about 2.82 kg. Another leopard cat was shot dead by the Kani tribals on 9th Dec. 1994, but we could not collect the specimen.

Rustyspotted Cat (*Felis rubiginosa* Geoffroy) was obtained from Indira Gandhi Wildlife Sanctuary in Tamil Nadu State 77° 17'-77° 90' N and 10° 20' - 10° 40' E). This cat was run over by a vehicle on the Udumelpet-Chinnar road near the Amaravathy reservoir. The skin of the cat was subsequently identified as the Rustyspotted Cat by J.C. Daniel of the Bombay Natural History Society.

We are reporting the site specific location of these two cats because the sighting of these nocturnal cats has become very rare in the Western Ghats.

November 27, 1995

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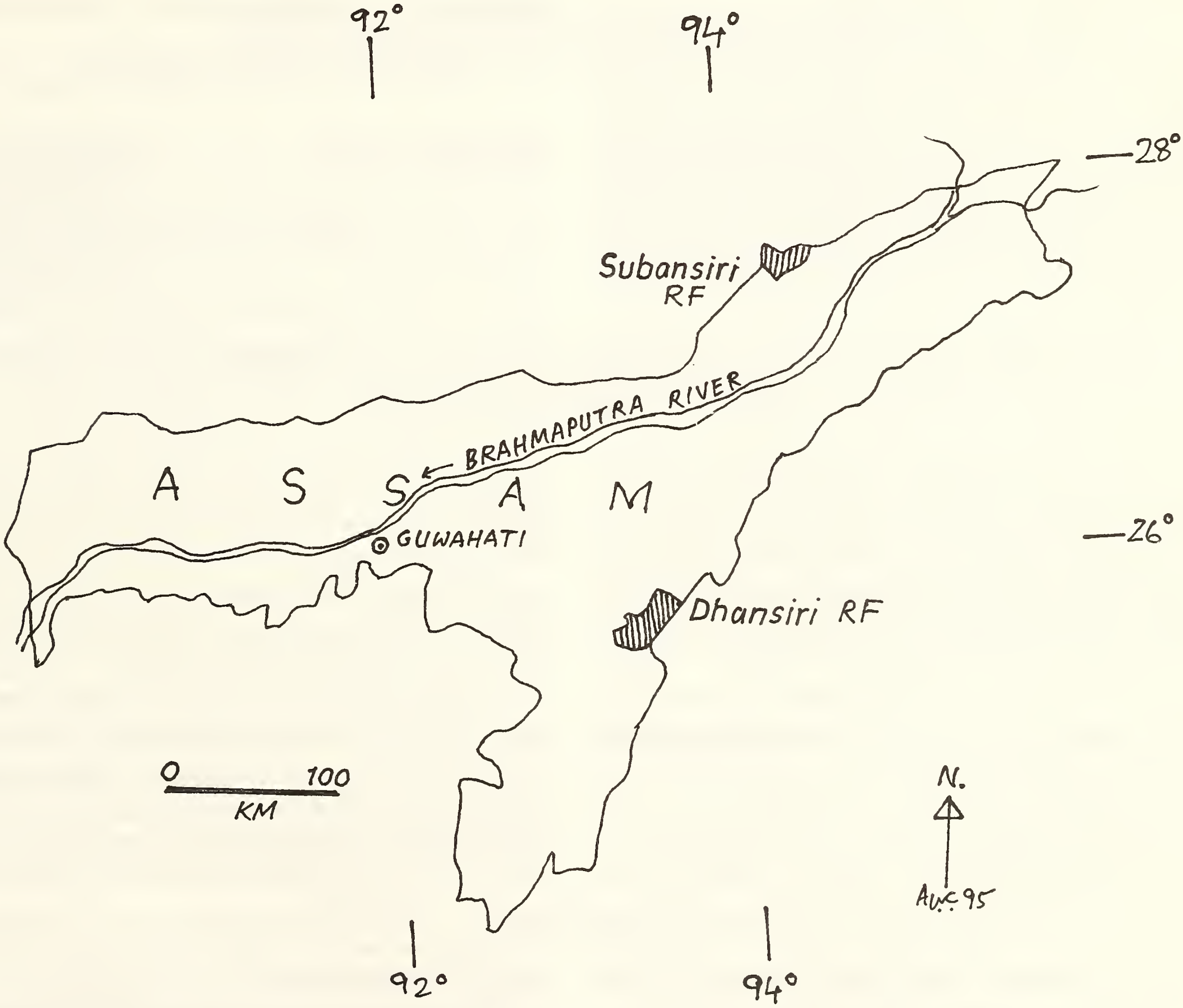
5. THE MARBLED CAT *FELIS MARMORATA* MARTIN IN ASSAM - SOME RECENT RECORDS

(*With one text-figure*)

The Marbled cat *Felis marmorata* (Martin) is a rare small felid known to occur in northeastern India extending westwards up to Nepal within the limits of the Indian Subcontinent (Prater, 1948). Its sighting and specific locality records are few and far between. I describe here three localities of confirmed reporting.

On 2 November, 1990, while on a field trip to Subansiri Reserve Forest (RF) in Dhemaji district, I obtained a skin in Dirpai village, a settlement of the Adi (Abor) tribe within the reserve forest. It was shot by a local shikari in the last week of October, 1990, while it was sitting on the ground at dawn. The site was not far from the village and was within the


92°
94°
28°
Subansiri RF
BRAHMAPUTRA RIVER
A S S A M
GUWAHATI
26°
Dhansiri RF
0 100
KM
N.
AUC 95
92°
94°

Map of Assam showing study areas.

reserve forest. While I was examining the skin, another local Adi came to me and reported that he had also killed a similar cat about a year back from the same reserve forest.

The Subansiri RF is mostly hilly being at the foot of the Eastern or Arunachal Himalaya and the habitat type is of tropical wet evergreen (now degraded at the lower reaches). Elevation in the forest ranges from 150 to above 1000 m. The cats seemed to have been shot at lower elevations.

On 10 August, 1991, I came across a skin in Muolzol Kuki village near Baghmari, south-west of Diphu town in Karbi Anglong District. It was killed by a local Karbi (Mikir) tribal hunter from the nearby Dhansiri RF in June-July, 1991.

One more skin was collected from a Karbi hamlet near Langcholiet on 3 May, 1992. It was also killed in the Dhansiri RF with the help of a *dao* on 27 April, 1992. Two local hunters (without gun) accompanied by trained dogs noticed the cat following latter's barking at a place *c* 9-10 km east of Langcholiet. It was on a tree-branch at about 6-7 m height.

The same hunters again saw a Marbled cat on 13 May, 1992, in the upper reaches of Karli Langso, *c* 6 km south-east of Langcholiet inside the Dhansiri RF.

The elevation of Dhansiri RF, where the cats have been recorded is about 200 m above msl. The habitat type is tropical semi-evergreen with a fairly good number of deciduous species. In comparison to Subansiri RF, this area is rather dry (rainfall less than 1000 mm a year while in Subansiri, it is around 3000 mm).

The specimen from Subansiri RF is the largest known in the world with a head-and-body length of 65 cm. The Baghmari specimen is 48 cm (only body), while that of Langcholiet specimen is 49 cm (head-and-body) and 49 cm (tail).

Both the areas are new localities for the species.

November 27, 1995

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6. GOAT PREDATION BY CLOUDED LEOPARD (*NEOFELIS NEBULOSA*) IN KAKOI RESERVE FOREST OF ASSAM

Kakoi Reserve Forest is about 19 km north of North Lakhimpur Town of Assam. In 1989 I was surveying the Kakoi and two other adjoining Reserve Forests, (the Ranga Reserve Forests and Dullong Reserve Forests) which are more or less contiguous along the foothills of Arunachal Pradesh.

On the morning of 3rd February, I was walking along a jungle track accompanied by a local wood cutter. Two km inside Kakoi R.F., our attention was attracted by a movement on the branches of a tree about 30 m to the left of the track. We could see two ravens hopping along the bough of a Hilikha tree and close to them was a black object perched in a fork of the main trunk. On moving closer to the tree we found the object to be a dead goat placed about 4 m above the ground.

On looking around we found three small pugmarks on a patch of a damp anthill. These pugmarks were a little smaller than those of a leopard. Since I had never seen a leopard taking its prey up on a tree, and had only heard of it, my curiosity was roused. I decided to enquire in the nearby hamlets, the residents of which had some goats.

An old Santhal (tribal) woman from a nearby hamlet in Johing, informed me that one of her goats had been killed the previous evening while they were browsing on the bank of Dejoo river, on the edge of the jungle, about 70 m away from her. Since it was late in the evening, the old woman could only see a leopard - like animal attacking one of her goats. According to her, the animal was smaller than a common leopard and its skin was "patchy".

Next morning at about 0600 hr. accompanied by the wood cutter, I proceeded towards the spot where the dead goat had been found. When we were about 22 m from the tree on which the dead goat was perched, I saw a leopard like animal lying on another horizontal bough close to the dead goat, and licking its right fore paw. Since we were facing the sun we could not get a clear view of the animal against the sun. We moved a little till we had an uninterrupted view of the animal. It was smaller than the common leopard, with large dull coloured patches all over the body.

We observed the animal for about 15-20 minutes, and from its size and colour pattern concluded that it was a clouded leopard.

We had been watching it for 15-20 minutes when the wood cutter brushed against a sapling, which made the leopard look in our direction and see us. It stood up on the bough and saw us more clearly. The wood cutter happened to remark that the leopard had seen us. On hearing the voice, the leopard rushed along the horizontal bough, and jumped down and vanished among the undergrowth.

November 27, 1995

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7. SIGHTING OF TAKIN (*BUDORCAS TAXICOLOR*) IN THE MEHAO WILDLIFE SANCTUARY, ARUNACHAL PRADESH

During my field work to study the vegetation and bird diversity of Mehao Wildlife Sanctuary, Dibang Valley, Arunachal Pradesh, I had the chance of sighting takin (*Budorcas taxicolor*). Takin is one of the rare and endangered rupicaprid (goat-antelope). It combines the features of the ox, goat and antelope. Its most striking feature is its convex 'face', heavy mouth, and thick neck. I was 150 m away from the animal, which was standing alone. There is a salt lick at this spot frequented by several ungulate species. The takin was grazing near the salt lick and did not move from the spot for nearly 20 minutes. Later, as we moved closer, the animal was disturbed and went down the steep valley. Since the terrain was very steep I could not get close in order to identify its sex, age and other features. A takin was reared by the Forest Department in an enclosure near the Mayodia guest house, which I used to observe closely whenever I was there. I was thus familiar with this animal and so there was no chance of misidentification. According to Prater (1971) the takin is found in the Bhutan Himalayas, the Mishmi Hills and in the mountains of the Salween-Irrawaddy divide. It was reported by Manjrekar *et al.* (1990) that only indirect evidence of takin was found in the Mehao Sanctuary, during the survey of the species. Later, on enquiry, I was told by the locals that while other ungulates such as serow and sambar were sighted by them frequently at the salt lick, the takin was a rare sighting for them also. This sighting confirms the presence of takin in the Sanctuary. The habitat in that particular area is still comparatively undisturbed, due to which the ungulate sightings are more frequent. The hunting pressure is also comparatively low in this part of the Sanctuary due to the tough, inaccessible terrain.

November 27, 1995

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8. A WHITE COOT AT KANEWAL, GUJARAT

We saw a white Coot *Fulica atra* amongst a total of 9100 black Coots feeding in the water on December 29, 1994 at Kanewal reservoir (22° 30' N, 72° 32' E) Kheda district, Gujarat. There were a few black splashes on the upper neck, wing coverts and tail region. A black line extended behind the eye on both the sides. The beak appeared light yellow as against pinkish white of normal black Coots. This white Coot was a member of a small group/flock of normal black Coots. There was no conspicuous difference in the feeding behaviour of the white individual nor did the normal individuals react differently to it. Earlier, we had seen one white Coot on January 13, 1988 at Pariej (22° 33' N, 72° 38' E) Kheda district, Gujarat.

June 12, 1995

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9. AN ALBINO REDVENTED BULBUL *PYCNONOTUS CAFER*

As a part of the survey of potential sites for reintroduction of the Asiatic lion, during May 1994 I visited Darrah Wildlife Sanctuary near Kota in Rajasthan. The sanctuary is only 3-5 km wide and about 80 km long. Close to the Arampur rest house, the Forest Department has constructed a hide overlooking two cemented water holes. Everyday after our field work, I used to sit inside the hide and watch the birds coming to the water hole. I recorded 21 species. The Redvented Bulbuls (*Pycnonotus cafer*) were the most abundant. On the second day of our stay, soon after we had returned from field at about 1330 hrs, I was attracted by a white bird which flew past the rest house and landed near the water hole. Immediately, I ran with my binoculars to the hide and saw a white bulbul. Its head was pale brown in colour, with rest of the body white and vent red. It was an albino Redvented bulbul. It bathed along with other redvented bulbuls and spotted doves (*Streptopelia chinensis*). I took a photograph. It flew and sat on a bamboo clump nearby due to the disturbance caused by the clicking of the camera. After 7 minutes it flew and disappeared into the *Anogeissus pendula* mixed forest. The next day also I saw the albino bulbul at 1340 hrs. at the water hole. During my five days at Darrah I saw this bird twice.

August 17, 1995

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10. ATTEMPTS OF FEMALE MAGPIE ROBIN TO CATCH A FISH

On 24 January, 1995 at about 1100 hrs, I was returning from the Kamalnath Reserve forest of Jhadol Range in Udaipur district. At the foothills, I observed a female Magpie Robin *Copsychus saularis* trying to catch a small fish in the shallow water of a hillstream. After a few attempts, it succeeded in picking it up in its bill but the fish quickly escaped and slipped into the water. The Robin again tried to catch it. While it was busy with the fish, a stray dog appeared and disturbed the Magpie robin which flew away.

April 4, 1995

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11. A NOTE ON THE ENDEMIC BROADTAILED GRASS WARBLER

On a brief visit to Upper Kodayar, Ashambu Hills, Tamilnadu, in September 1992, I had the good fortune of encountering one of the rarely seen endemic birds of the Western Ghats - the Broadtailed Grass Warbler (*Schoenicola platyura*). This bird is found in the grassy areas in the hills of Western Ghats south of Belgaum (Karnataka state) between 900 m to 2000 m (HANDBOOK Vol 8. pg 93-94). The only encounter I had earlier had with this bird was at the Poochippara area in the Silent Valley National Park in Kerala, in December 1990, in a grassy area.

The altitude at Upper Kodayar is over 1500 m and the habitat is mainly grassland-shola forest type. On 10th September, I saw a single bird on a Lantana bush opposite the Staff Quarters, close to the reservoir, where the habitat is greatly disturbed. The bird appeared to have a tail moult and we could see the fine markings on the tail. When it called, we could make out the pinkish mouth.

On the next day, we visited the Seventh Saddle area, *en route* to Muthukuzhi. Here, from among the tall grass and low bushes, we could hear single noted "pink" calls. We stopped to take a closer look and we saw atleast three individuals of the Broadtailed Grass Warbler. The birds were calling the single-noted calls as well as a series of warbling notes that sounded like those of a lark. A few mimicking notes were also heard. The calls were uttered while perched as well as in flight. The birds took off from their perches at angles of 45° to about 15 m in the air, singing for brief periods and then diving back into cover. Though they were shy, we managed to get good views of the bird and we could see the dark mouths of the singing birds, a feature also seen by R. Kannan at Grass Hills, Annamalai, Tamilnadu (pers. comm).

The breeding season of this bird has been described in the HANDBOOK (Ali & Ripley, 1987) as March-May and July-September. The presence of singing and displaying birds in mid-September indicates that the nesting season may well extend further. More observations are needed to determine this.

I am grateful to my colleague and good friend T. Ganesh for hosting me during my stay at Kodayar and accompanying me to the field.

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12. WHITEBROWED BLUE FLYCATCHER (*MUSCICAPA SUPERCILIARIS*) DELINEATION OF ITS WINTERING RANGE IN WEST INDIA

This attractive little flycatcher is a summer breeding bird of the middle elevations of the entire Himalayan range. It winters over a wide area of the Indian peninsula rather vaguely indicated in the HANDBOOK and the SYNOPSIS thus: "In Central India from Delhi south to Northern Maharashtra, Southeastern Karnataka, Northwestern Andhra, Orissa, Bengal and Bihar. Recorded from Bahawalpur in Pakistan (no date)."

One supposes that it is absent from the Western Ghats and the plateau country of Marathwada, Andhra and Karnataka. Presumably Abu and the hills of eastern Gujarat are in the range though the species does not figure in the Gujarat list. It therefore seems worth recording two sightings from Gujarat.

Shri Lalsinhbhai Raol, a highly competent birdwatcher spoke to me about a drawing given to him by Dr. Bakul Trivedi who made it during a WWF-I outing to the Jessor Hills just south of Mt. Abu. The prominent white eyebrow, blue upperparts and white underparts with a prominent greyish band broken by white on the chest were shown.

Lalsinhbhai and Dr. Trivedi went out birding to Himmatnagar on 5th February and in a grove of trees edging the river at Shareneshwar temple, Dr. Trivedi pointed out his puzzle bird. Lalsinhbhai has seen the Whitebrowed Blue Flycatcher in the Himalaya. Lalsinhbhai mentions Redbreasted Flycatchers also being around. The two species are the same size, have very similar calls and demonstrate common mannerisms, and though the males are distinctive, the females resemble each other. These facts suggest why the Blue may have been given a go by.

Shareneshwar is between the towns of Idar and Vijaynagar in Sabar Kantha (Himmatnagar) District northeast of Ahmedabad.

April 6, 1995

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13. NOTES ON GREEN MUNIA

Seven species of munia are found in the Indian subcontinent (Ali & Ripley 1987). Of these, the Green munia (*Estrilda formosa*) is listed as threatened in India (Collar, Crossby and Stattersfield 1994).

The green munia is an endemic species, very locally and unevenly distributed. It is found mainly in central India from Mt. Abu, Gwalior, Jhansi and Surguja south to Mahabaleshwar, district Adilabad and upto the Vishakhapatnam Ghats. It is also recorded from Lucknow and Lahore and from Bihar (Ali & Ripley 1983). In recent years nothing has been reported on the species, although it is a popular cage bird.

I conducted a short survey between 5-7 June, 1994, on the species around Jhansi in Uttar Pradesh. According to the information gathered from local bird trappers, the species has been largely wiped out from near Jhansi although a few populations do exist near Tikamgarh. An extensive two day search on the Chatarpur road resulted in locating a small population in a nearby village, (name of the village is not given for obvious reasons). An isolated population of about 60 to 70 birds was seen in a stony, arid wasteland. They appear to move around in a limited area of about 1 sq. km.

The survey was done in the non-breeding season. The maximum flock size was seven. The first bird was sighted at 0545 hrs and I could observe them almost throughout the day. Bimodal activity pattern of feeding was noticed. Most of the long-duration sightings were in the afternoon when the birds used to gather and rest in *Ipomea* shrubs. The birds were seen reaching the resting site from 0900 hrs where they remained till 1500 hrs. The resting site was comparatively cool due to water and presence of vegetation. The day resting site was shaded by tall, dense *Ficus* trees.

It was seen that the Green Munia mostly keep to themselves while resting and foraging. It was also observed that they never roosted communally with the Red munia (*Estrilda amandava*) or other species in congregation in the sugarcane field. This is also confirmed by trappers who catch many species of munias (Red or Spotted) in large numbers in sugarcane fields, but never get the Green Munia in these flocks.

Other birds seen in the vicinity of the Green munia sharing the same resources were the Red munia (*Estrilda amandava*), Spotted munia (*Lonchura punctulata*), Whitethroated munia (*L. malabarica*), Blackheaded munia (*L. malacca*), Baya (*Ploceus philippinus*), Black-throated baya (*P. benghalensis*) and Streaked weaver (*P. manyar*).

The Green munia is not a shy bird; it could be approached as close as 8-10 m and was found near human habitations. When approached they used to fly to nearby bushes, and while doing so the green colour on their back perfectly camouflaged them with the surroundings. Often it was seen that two birds, most likely a pair, would sit on a branch and when excited would flatten their tail, pointing towards each other while uttering a high pitched note.

According to a TRAFFIC-India report on live birds (Ahmed and Menon, 1995), it seems that trapping is a threat to its population which is true to a very large extent. Previous visits to Lucknow, and information from Mt. Abu have also confirmed that most isolated populations near these places and in many areas of Madhya Pradesh have been wiped out by bird trappers as this bird can be easily caught with baiting and decoy birds, and trappers can catch most of the individuals of an area.

There is a need for a full fledged project on the Green Munia to study the various aspects of its biology and also the impact of trapping the species.

ACKNOWLEDGEMENT

I am thankful to Dr. Asad R. Rahmani for his suggestion on this article and also to Zafar-ul Islam for assisting in its preparation.

March 31, 1995

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14. COMMENTS ON SOME NEW BIRD RECORDS FROM TAMILNADU

In a recent issue of the *Journal*, S. Balachandran has reported a few new records in certain bird species in Tamilnadu (*JBNHS*: 91(2): 314; 317-318; 322-323; 1994). These include breeding records of Coot and occurrences of the Indian Courser, Black Redstart and Small Minivet. I have a few comments to make on these notes.

The breeding of Coot (*Fulica atra*) in Coimbatore (Tamilnadu) in 1983 was earlier reported by P.S. Sivaprasad (*Blackbuck*, 2(2): 17-19, 1986). These birds continue to breed in the same area and even recently, in 1995, young birds were seen (Sivaprasad, pers. comm.). Breeding of Coots has also been reported recently in Kerala by C. Sushanth Kumar (*Newsletter for Birdwatchers*, 33: 55, 1993).

Although the Indian Courser (*Cursorius coromandelicus*) is not a common bird, it is certainly not as rare as suggested by Balachandran. It occurs mostly in dry, stony, open areas, dried-up lake margins etc., and I have seen birds in suitable habitats around Madras in small numbers. These include open areas near Vendanthangal, Velacherry (outskirts of Madras city), near Thirupporur (off the old Mahabalipuram Road) and along the road from

Gummudipoondi to Sathyavedu (north of Madras city) and at Kaliveli. I am sure the bird occurs in appropriate habitats elsewhere in the state.

The Black Redstart (*Phoenicurus ochruros*) is an uncommon winter visitor around Madras and has been recorded in different years at the Guindy National Park and the environs of the Chembarambakkam Lake. Both male and female birds have been seen in the winter months. It has also been recorded recently in Kerala (Neelakantan *et al. A. Book of Kerala Birds* (*Part I*) WWF-Kerala, pp 88-89, 1993).

The Small minivet (*Pericrocotus cinnamomeus*) is a fairly common bird in the coastal areas of Madras and is seen in Guindy National Park, Theosophical Society Campus, and Madras Christian College Campus, besides other fairly wooded village environs and scrub jungles. I am surprised that this species has not been recorded at Pt. Calimere earlier.

March 31, 1995

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15. NEW LOCALITIES FOR BROWN HILL TORTOISE *MANOURIA EMYS* (SCHLECAGEL AND MULLER) FROM KARBI ANGLONG, ASSAM

The Brown hill tortoise (*Manouria emys*) is also called the Asian brown tortoise, Burmese brown tortoise and Eastern hill tortoise. It is the largest land tortoise of Asia. The colour of the carapace is brownish to brownish-black. The species attains a length of upto 60 cm.

In India, this tortoise has been recorded in Nagaland (Anderson, 1872), Nongkhyllem Reserved Forest in Meghalaya (Das, 1991: Colour Guide), Langting-Mupa Reserved Forest and some other localities of North Cachar Hills in south-central Assam (Anderson, 1871, 1872). Outside, it extends upto Sumatra.

In March, 1992, I examined a partly damaged carapace in Kaliyani Reserved Forest of northern part of Karbi Anglong district in central Assam (26° 25' N; 93° 35' E). Only the straight carapace width could be measured (37 cm). In October, 1995, a live tortoise was caught by some local tribals in Tarapung area (26° 30' N; 93° 30' E) of the same district and brought to Bokakhat market near Kaziranga National Park for sale. It was then rescued by the civil officials and sent to the Assam State Zoo at Guwahati.

It measured (in cm), Straight line carapace length: 53; Curved carapace length: 62; Straight line carapace width: 36; Curved carapace width: 56; Plastron (greatest length): 56; Plastron length (notch to notch): 52; Shell height: 21. It weighed 21 kg.

September 17, 1996

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16. THE KEELED BOX TURTLE *PYXIDEA MOUHOTII* GRAY - A NEW RECORD FOR MANIPUR

The keeled box turtle *Pyxidea mouhotii* Gray, 1862, has been recorded from only a few localities in the north-east of India, i.e., North Cachar Hills (Das, 1991) and Karbi Anglong (Choudhury, 1993;

JBNHS 90:517) of Assam, Khasi and Garo Hills of Meghalaya, Namdapha National Park (Das, 1991), Mehao Sanctuary (Bhupathy and Choudhury, 1992) and Drupong Reserved Forest (Choudhury, 1996; JBNHS 93:97) of Arunachal Pradesh. All the records except the last one were from the south bank areas of the Brahmaputra river.

On 20 January, 1996, while driving from Imphal in Manipur to Hailakandi in southern Assam, I obtained a carapace of a Keeled box turtle from a road labourer's camp, located between the Barak and Makru rivers (*c.* 6 km road distance from Barak bridge), at an elevation *c.* 200 m above msl, in Tamenglong district of Manipur. The turtle was caught by a labourer from a nearby forested hill-slope.

The carapace (AUC 45) measured (in cm): Straight line carapace length 14.1; Curved carapace length 15.9; Straight line carapace width 11.0; Curved carapace width 15.6 and Carapace height 4.9

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17. OCCURRENCE OF INDIAN PEACOCK SHELL TURTLE IN GAUHATI UNIVERSITY CAMPUS

The Gauhati University Campus was built in low marshy areas where a small fragmented wetland (not more than 2.5 ha.) still provides good habitat for wetland fauna.

On 12th August, 1995 a local villager from nearby caught a soft shell turtle on his hook in the Gauhati University campus. The carapace length and width were 26 cm and 22 cm respectively. Length of head plus neck was 20 cm. The clearly reticulate carapace was dark green in colour with four easily distinguished round spots with lighter boundary. The snout was light green with dark spots. Three nails were present in each limb whereas another two nails were covered by skin and formed a pad - like structure. After consulting various books the turtle was identified as the Indian Peacock soft shell Turtle *Aspideretes hurum.* The habitat where it was caught is low marshy land with paddy cultivation on its edge line and was situated behind the Department of Zoology, with an area of about 1.5 ha. The person who caught the turtle refused to sell it to me.

June 4, 1996

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18. A RECORD CLUTCH SIZE OF RAT SNAKE

The normal clutch size of Rat Snake (*Coluber mucosus*) is reported to consist of 6-14 eggs (Smith 1943 & Daniel 1983). Recently we came across a clutch of Rat snake's eggs from Mannuthy, Kerala on 28th September, 1995, from a heap of soil near a house. There were 32 eggs in the clutch. A few eggs could have been lost as evident from the remains of shells. The eggs had an average size of 46.8 x 31.5 mm and weighed 19.35 gm. The eggs were leathery, both sides equally domed and were stuck together. Young ones were also found at the site and measured about 40 cm. The clutch size is a record for Rat snake.

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19. BREEDING SEASON OF HORSE-SHOE PIT VIPER (*TRIMERESURUS STRIGATUS*) IN NILGIRI BIOSPHERE RESERVE

The Western Ghats is one of the well known areas of biodiversity and endemism. It is reported that 89 of 117 amphibian species (Daniels 1992) and 48 of 112 species of reptiles are endemic. Six species of pit vipers have been reported from the Western Ghats (Smith 1943). They are Hump nosed (*Hypnale hypnale*), Largescaled (*Trimeresurus macrolepis*), Malabar (*T. malabaricus*), Horse-shoe (*T. strigatus*), Bamboo (*T. graminius*) and Hutton's (*T. huttoni*) pit vipers (Smith 1943 & 1949). Indian vipers are ovoviviparous. The present report is based on an observation from Mukkuruthi National Park, Nilgiri Biosphere Reserve (NBR). Mukkuruthi National park is a part of the higher hills (1800-2500 m above msl) of NBR. The dominant vegetation type of this area is Montane Shola Grassland.

On 21 September 1995, while conducting a lizard survey in the Western catchment of this National Park, we located a viper which was identified as Horse-shoe pit viper (*Trimeresurus strigatus*) based on the description by Smith (1943). The snake was basking on a barren rock surrounded by boulders. The ambient temperature was less than 12° C (10.00 AM). The area was wet as there was a stream close by. This species is reported to be distributed in Nilgiri, Annamalai, Sevaroy, Palani and Tirunelveli hills (Smith 1943).

The viper measured 365 mm in snout-vent length and 55 mm in tail length. Five developing eggs were felt by palpation. Breeding season of this species has not been recorded so far (Smith 1943, Murthy 1990). Based on the present observation, it appears that the Horse-shoe pit viper breeds in the post monsoon season. In the same general locality i.e. Western Catchment of Mukkuruthi National Park, other reptile species such as the whip snake (*Ahaetulla perroteti*) and Nilgiri Salea (*Salea horsfieldi*) are common.

We record our sincere thanks to the World Wide Fund for Nature (WWF) India for financial assistance and Tamil Nadu Forest Department for permission to work in Mukkuruthi National Park.

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20. EXTENSION OF RANGE OF *SILURUS WYNAADENSIS* DAY (PISCES: SILURIFORMES: SILURIDAE)

During the course of a faunistic survey in the hill ranges of the Kasaragod district of Kerala, the survey team of Z.S.I. collected two specimens of the Siluroid fish, *Silurus wynaadensis* Day, 1873, from a hill stream at Ranipuram, a forest locality situated at an elevation of about 760 m above m.s.l. on the southeastern part of the district. All the streams originating in the hill ranges of the district empty into the west flowing rivers in the district. The hill stream wherein *Silurus wynaadensis* Day was found is spring-fed and forms the headwaters of the river Chandragiri, one of the major west flowing rivers in the district.

Silurus wynaadensis Day is distinguished from other species in the genus by having the vomerine band of teeth interrupted, the premaxillary teeth in a continuous narrow band, four mandibular barbels, anal with 58-62 rays and pectoral with 10 branched rays.

The occurrence of *Silurus wynaadensis* Day in a west flowing river in Kasaragod is an extension of its range in Kerala. Out of the three species of the genus *Silurus* Linn. found in India (Haig 1950), *Silurus wynaadensis* Day is so far known to occur in the east flowing rivers of the Western Ghats, from Wynaad in Kerala (Day, 1873, 1878) and from the Jaggar valley in Karnataka (Bhimachar and Rau, 1941) associated with the drainage systems of the rivers Cauvery and Tungabhadra respectively. Later Rajan (1955) reported this species from the headwaters of Bhavani river which is also a tributary of Cauvery.

The present record of this species is the first in Kerala in a west flowing river.

The material examined (2 specimens 60-61.5 mm. SL, Ranipuram, 10 September, 1993) is deposited in the W.G.F.R.S. (Calicut), Zoological Survey of India.

ACKNOWLEDGEMENTS

I thank the Director, Zoological Survey of India, Calcutta and the Officer-in-Charge, Western Ghat Field Research Station, Z.S.I., Calicut for providing facilities and encouragement.

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21. *MYSTUS TENGARA* (HAMILTON) (SILURIFORMES: BAGRIDAE) - AN ADDITION TO THE ICHTHYOFAUNA OF JAMMU (TAWI), INDIA.

Bagrid catfishes of the genus *Mystus* Scopoli are primary freshwater catfishes which are widely distributed in southeast Asia, the Indo-Australian islands and Africa, being found in Syria in west Asia through India, Nepal, Pakistan to Sri Lanka in the south, through Bangladesh, Burma, Thailand, Indo-China, Malaysia to East Indies, and China in the east. A few species enter the seas and estuaries. *Mystus* Scopoli and *Rita* Bleeker are known as fossils from the Pliocene of the Siwaliks (Lydekkar 1886). The African genus *Porcus* is considered the ancestor of *Mystus,* indicating the African origin of the latter genus (Jayaram 1966, 1974).

In the ichthyofauna of Jammu Province of Jammu and Kashmir State, catfishes of the genus *Mystus* are represented by two species, *M. bleekeri*

(Day) and *M. vittatus* (Bloch), along with one species of an allied genus *Aorichthys* Wu, namely, *A. seenghala* (Sykes). All these species are slow-current dwelling forms and occur in meandering portions of the Tawi (Nath 1989).

During recent investigations on the fish fauna of the River Tawi (a tributary of the Chenab drainage system), a large number of specimens of *Mystus tengara* (Hamilton) was obtained from the river at Jammu during April and May, 1995. *M. tengara* is widely distributed throughout northern India as well as Bangladesh and Pakistan (Jayaram 1981). As there is no previous record of the occurrence of this species of *Mystus* from Jammu (Tawi) to date, the present report is a new record for Jammu and Kashmir State (Nath 1992, 1994).

DISCUSSION

When we compare the ichthyofauna of Jammu Province with that of Kashmir Province as well as Ladakh region, the complete absence of Bagrid catfishes from Kashmir and Ladakh is quite significant. The nearly complete isolation of Kashmir region from Jammu Province by the Pir Panjal range mountain-barrier has excluded many of the fish species of Kashmir region from Jammu region and vice versa. The total absence of the representatives of the families Bagridae, Schilbeidae, Heteropneustidae, Amblycipitidae, Mastacembelidae, Belonidae, Gobiidae, Belontidae, Channidae and Chandidae of Jammu region from the Kashmir Valley suggests that the high Pir Panjal range was already established when these fishes of the Indian region migrated towards the north, but were prevented from entering Kashmir by the formidable Pir Panjal mountain range. The origin of fishes of Jammu Province is from the Indo-Gangetic region (together with a few species from Kashmir region), to which region there was migration from east to west from southeast Asia. Evidence exists that the fishes of Jammu region have probably migrated to their present habitat only in the late Pleistocene (Das 1966; Das and Nath 1971; Nath 1986).

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22. *NEOCONOCEPHALUS* SPP. A LONG HORNED GRASSHOPPER (TETTIGONIIDAE: ORTHOPTERA) FEED ON SMALL BLACK ANT

On 1st, September 1995 I was in the garden collecting insect pests of a bean vegetable. It was around 4.30 p.m., that I found a long horned grasshopper *Neoconocephalus* spp., family Tettigoniidae, descriptive and pictographic identification from Imms (1965), lifting one hind leg, on whose tarsus a black ant was biting. The reason for the biting could not be known. The hopper jerked its leg up and down due to the pain of the bite, tried to free itself from the ant, but could not. Suddenly it brought the tarsal portion of the hind leg on which the ant was biting, below its body to the mouth. The hopper caught the ant with its mandibles and ate it up completely within a moment.

M.S. Mani (1982) states that Tettigoniids are mostly diurnal forms that are usually herbivorous. And hence the above mentioned feeding behaviour is unusual.

During my study on insect pests of bean, predatory behaviour of the the long horned grasshopper on ants has not been observed. However, the above observation indicates that under compelling circumstances, a long horned grasshopper can feed on small black ants. This behaviour needs further observation.

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23. ARE ANTS SECONDARY DISPERSERS OF FIG SEEDS IN INDIAN FORESTS?

Apart from vertebrates, which are major dispersers of seeds, several invertebrates are also known to assist in the dispersal. Beetles, earthworms, snails and ants are known to disperse seeds which may even lead to the rearrangement of the seed shadow (Beattie and Culver 1982, Roberts and Heithaus 1986). Studies have shown that fig seeds are regularly subjected to secondary dispersal by ants which harvest the lipid-containing exocarp (elaisome) of the small fig seeds (Roberts and Heithaus 1986, Kaufmann *et al.* 1991). Despite the richness of *Ficus* species in the Indian subcontinent, information on this aspect of its seed dispersal is lacking.

While studying several aspects of fig ecology (Athreya 1993) in Karian Shola National Park, Indira Gandhi Wildlife Sanctuary, Western Ghats, I came across several indications that the secondary dispersal of *Ficus* seeds by ants may occur even in Indian forests. The vegetation of this area is dominated by the west-coast tropical evergreen forest type of Champion and Seth (1968) with *Hopea parviflora* and *Messua ferrea* being the characteristic tree species. *Ficus* trees are quite common within the National Park, especially in relatively open areas (unpubl. data).

I came across armies of ants carrying away fig seeds from fallen fruits and droppings of frugivores from under trees of *F. microcarpa* and *F. drupacea* (both strangler figs). This was also noticed for the fig seeds which formed a major fraction of the copious droppings of Great Pied Hornbills (*Buceros bicornis*) below their nest-holes.

I also split open some ripe figs of *F. exasperata* (free-living *Ficus*) and *F. drupacea* and placed them at my camp site. The same evening I saw ants carrying away the seeds from all the figs, although the seeds of *F. exasperata* seemed to be less popular. However, both species of figs were devoid of seeds by the next morning.

It has been said elsewhere that the lipid-containing exocarp is not affected by the passage through the vertebrate gut and is still harvested by the ants (Kaufmann *et al.* 1991). Ants are known to be responsible for *Ficus* seedlings taking root in crevices in vertical surfaces (Kaufmann *et al.* 1991).

This system of secondary dispersal of fig seeds by ants has not been studied in any Indian forest. Although this note is of a qualitative nature, a detailed study of this aspect may throw some light on the importance of the role played by invertebrates in affecting the seed shadow of figs, especially strangler figs, which require specific microhabitats for successful germination (Putz and Holbrook 1986).

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24. THE SPOT PUFFIN BUTTERFLY *APPIAS LALAGE LALAGE* DOUBLEDAY (PIERIDAE) - A RARE RECORD FOR SOUTH INDIA

The butterfly *Appias lalage lalage* has been recorded in the United Provinces, Mussooree to Burma, Tavoy (Talbot 1939). Its range is also mentioned from Simla to Burma and Assam by Wynter-Blyth (1957). D'Abrera (1982) states its range as Assam to upper Burma and Antram (1924) noted it as a rare species recorded from the Himalayas, Sikkim, Bhutan and Assam. The only record found from South India was at the Netterikkal region of the Kalakkad forest, Tiruneveli District, Tamil Nadu (Satyamurti 1966).

A single male specimen of the wet season form with a wingspan of 76mm was taken in Gudampara Estate, Santhanpara panchayat, Idukki District, Kerala at an elevation of 1200 m above msl on December, 3, 1995. The butterfly was mudpuddling at noon near a small stream flowing through a coffee plantation.

It appears to be one of the few records of the Spot Puffin from South India and may be the first record from Kerala. This shows that this butterfly though rare, does exist in the Western Ghats apart from its known range. The specimen is now in the Gudampara Biopark Project collection.

April 4, 1996

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25. NEW RECORDS OF PLANTS FOR INDIA

During the course of studies on Flora of Sikkim, six interesting collections were recorded, which were compared with the type specimens housed in CAL, BM & K herbaria, and identified. They turned out to be new records for the Flora of India. Brief taxonomic accounts are provided to facilitate their identification in the field.

1. **Berberis tsarica** Ahrendt in J. Bot. Lond. lxxix, suppl. 48.1941. (Berberidaceae). Deciduous shrubs, upto 1m tall. Stems angular, densely spiny, spines mostly 5-fid, internodes *ca* 7 mm. Leaves oblanceolate, 7-15 x 2.5 - 4.5 mm, obtuse mucronate at apices, margins entire or with a few spinose teeth. Flowers solitary; pedicels 3-10 mm long. Sepals elliptic, 4-5 x 3 mm. Petals obovate, *ca* 4 x 2.5 mm, apices emarginate. Stamens 2.5 - 3 mm long. Berries broadly ellipsoid, 8-10 x 5-7 mm, red.

Fl. & Fr.: Aug.-Sept.

Specimens examined: Sikkim, s.l., Cave 530 (E?): Momay-Samdong, 15000 ft, Cave 40/47 (E!).

2. **Carex montis-everestii** Kuekenth. in Kew Bull. 1934:261.1934.

(Cyperaceae). Perennial rhizomatous herbs. Culms upto 15 cm high, subterete. Leaf-sheaths reddish-brown at base, persistent. Leaves basal, upto 7 x 0.15 cm, erect. Inflorescence consists of 2-3 spikes; terminal spike male or gynaandrous, narrowly ellipsoid, borne on suberect, 0.5 - cm long peduncles; lower spikes female, broadly cylindric, *ca* 1.2 x 0.8 cm, produced on pendant, filiform peduncles, Lowest bracts filiform, shorter than inflorescence. Utricles elliptic, *ca* 4.5 x 1 mm, glabrous, shining, reddish-chestnut above, pale beneath, minutely notched at the orifice; beakless. Stigmas 3. Female glumes oblanceolate, up to 5.5 x 2 mm, acute, dark reddish-brown. Male glumes upto 6 x 1.2 mm.

Fl. & Fr.: July-Aug.

Specimens examined: Llhonak, 15000 ft, Smith & Cave 1879, 2155 (CAL!).

3. **Carex pseudofoetida** Kuekenth. ssp. *afghanica* Kukkonen in Ann. Bot. Fennici 21:384.1984. (Cyperaceae). Perennial herbs up to 2.5 m high, rather gracile. Rhizomes stoloniferous. Culms obtusely trigonous, 1-1.8 mm in diam., smooth or occasionally scabrid above. Leaves folded or involute, rarely flat, 1.5 - 3 mm wide. Inflorescence a rather compact head, 10-15 x 7-12 mm; bracts shorter than apices; glumes 2.8 - 4.1 x 1.5 - 2 mm, scabrous. Utricles 3-4 x 1.2 - 1.8 mm, beaked, more or less inflated, obscurely nerved.

Fl. & Fr.: July-Aug.

Specimens examined: Sikkim, *s.l., Raju et al.* 8060, 8063 (BSHC!); Above Llohank, 4780 m, KEKE dt. 1989 (E!).

4. **Xanthosoma brasiliense** Engl., Pflanzenr. Arac. - Cococas. 58.1920.

(Araceae). Stemless herbs. Leaf-blades hastate, up to 48 x 15 cm, veins of basal lobes exposed for *ca* 1 cm; intramarginal veins conspicuous; petioles up to 40 cm long. Spadix with appendix. Ovary 2-4 locules, with numerous ovules; stylar discs coherent between adjacent female flowers.

Fl. & Fr.: Sept.-Oct.

Specimen examined: Gangtok, *ca* 11 km in north on Gangtok - Kabri road, *ca* 1700 m, ESIK s.n. (BSHC!. E!).

Notes: A native of tropical America; now almost naturalised in Sikkim upto 1700 m to Peshok and Mungpo areas of Darjeeling district of West

Bengal.

5. **Soroseris hookeriana** (Clarke) Stebbins in Mem. Torr. Bot. Club. 19, 3: 45.1940 *Crepis hookeriana* Clarke, Comp. Ind. 255.1876.

(Asteraceae). Dwarf perennial herbs. Leaves oblong to lanceolate, shallowly lobed, toothed or entire. Flowering stems 3-10 cm high. Inflorescence compact, almost stalkless, of many yellow flowered-heads and a rosette of narrow leaves. Ray-florets 4, oblong, 1 - 1.7 cm, conspicuously 5-toothed at apex; involucre bracts linear, blunt, woolly at base, almost glabrous towards apex.

Fl. & Fr.: July-Sept.

Specimens examined: Katao, *ca* 4800m, R.C. Srivastava, s.n. dt. Sept. 1989 (BSHC).

Notes: Rao *et al.* (1988) recognised the occurrence of only one species viz. *Soroseris deasyi* (S. Moore) Stebbins in India. However, the identity of the present collection was confirmed by Dr. C. Jeffrey, Royal Botanic Gardens, Kew.

6. **Zephyranthes candida** Herb. in Bot. Mag.t. 2607.1826.

Herbs. Bulbs *ca* 2.5 cm in diam., with prominent neck. Leaves linear, upto 30 cm long, present during flowering. Flowers white, perianth *ca* 5 cm long, without tube, segments obtuse or short acute, upto 1.2 cm wide. Stamens much shorter than the segments; styles somewhat exceeding stamens; stigma slightly 3-notched.

Fl. & Fr.: Aug.

Specimen examined: Gangtok, *ca* 1750 m, R.C. Srivastava, s.n. dt. July 1992 (BSHC!).

Notes: Probably an escape but now almost naturalised. Not known so far from India (*cf.* Karthik. *et al.* 1989).

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September 8, 1995

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26. A NEW RECORD FOR FLORA OF INDIA FROM SIKKIM

During the course of studies on Flora of Sikkim, we came across an interesting collection which was later identified as *Berberis everestiana* Ahrendt var. *ventosa* Ahrendt. This taxon has not been recorded from India so far. Hence, a brief description with data on distribution, flowering/ fruiting period etc. is provided.

Berberis everestiana Ahrendt var. *ventosa* Ahrendt, J. Linn. Soc. (Bot.) 57:117.1961.

Small shrubs. Stems very sulcate; shoots reddish; pale yellow with age. Internodes 5-12 mm. Spines 3(-5)-fid, 5-12 mm. Leaves obovate, 5-15 x 3-8 mm, entire or with margins with 2-3 spinose serrations. Flowers solitary. Pedicels 5-8 mm long. Outer sepals ovate- elliptic, *ca* 6 x 3 mm, subacute; inner sepals obovate, 7.5 x 4.5 mm. Petals *ca* 6 x 3 mm, subacute; inner sepals obovate 7.5 x 4.5 mm. Petals *ca* 6 x 3 mm. Stamens *ca* 4 mm, produced, apiculate. Berries oblong-ovoid, ca 7 x 4 mm.

Fl. & Fr.: June-Sept.

Distrib.: Nepal, India (Sikkim)

Specimens examined: North Sikkim district:

Muguthang, Army camp area, S.K. Rai 9490 (BSBC!).

Note: This variety is distinguishable from var. *everestiana* by the following main characters:

DISTINGUISHING CHARACTERS OF TWO VARIETIES OF *Berberis everstiana* AHRENDT

S.N.	var. *everestiana*	var. *ventosa*
1.	Leaves entire, never spinulose	Leaves sometimes spinulose
2.	Stamens truncate	Stamens apiculate
3.	Fruits 9-10 mm	Fruits *c* 7 mm
4.	Seeds purple	Seeds yellow-brown

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September 7, 1995

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27. STUDIES OF VIVIPAROUS GERMINATION IN *ARTOCARPUS HETEROPHYLLUS* LAM

Vivipary is the germination of seeds in the fruit while the fruit still remains attached to the plant; it is particularly common in mangrove plants. There are relatively few certain records of viviparous germination in mesophytes like *Pennisetum* (Reddy and Chatterjee, 1976), *Livistona chinensis* (Kulkarni and Pandey, 1976), *Allium cepa* (Foja *et al.*, 1967), *Citrullus vulgaris* (Singh and Sharma, 1972), *Sechium edule* (Katiyar, 1976), etc. The present case is a new addition to the list.

200 mature fruits of *Artocarpus heterophyllus* were collected from different regions of Kanyakumari district of Tamil Nadu, India and from markets to study the presence of viviparous germination in them. Germinated seeds in the fruits were collected from the ripe fruits by cutting them with a sharp knife. Of the 200 fruits studied, 23 fruits had germinated seeds in them. 573 germinated seeds were collected from the 23 fruits. Length of shoot and root of each of the seedlings were measured using a metre scale. The maximum height of the shoot was 9.8 cm, and of the root was 10.2 cm. The average height of the shoots was 6.3 cm, and of the roots was 7.6 cm. Then 300 dormant seeds were collected from fruits that did not have germinated seeds and sowed in the garden soil to raise seedlings. The seeds took four days for germination under normal conditions. After germination, 25 seedlings were uprooted from the nursery every day without damaging their roots and the average height of shoots and roots were measured as usual. The height of the shoot reached 6.3 cm on the 6th day after germination, and of the roots reached 7.6 cm on the 7th day after germination. The seedlings took 9 days for producing shoots of 9.8 cm height. The shoots of viviparous seedlings were pale yellow in colour with soft stem. They became green within two days when they were exposed to sunlight. The growth was somewhat rapid in roots as compared to shoot growth. But in artificial germination the shoot growth was higher than the root growth. This shows that the internal environment of such fruits is more suitable for seed germination than the soil.

The ripe ovaries around the germinated as well as dormant seeds were collected from viviparous and non-viviparous fruits respectively, and their moisture content was measured using weighing method. The moisture percentage was the same (89.3%). This was also done in ovaries whose seeds were at the stage of sprouting. The moisture percentage of ovaries containing sprouting seeds was 79.1% and that of ovaries containing non-viviparous seeds was found to be 71.72%. The high moisture content in viviparous fruits before ripening might be the reason for the viviparous germination.

Kulkarni and Pandey (1976) pointed out that humidity was the main reason for viviparous germination in *Livistona chinensis.* In the present case also, the moisture content was higher in ovaries of viviparous fruits than in ovaries of fruits whose seeds were dormant. The increase in moisture content before ripening might be the reason for viviparous germination in *Artocarpus heterophyllus.* The roots of viviparous seedlings produced a thick dense mat of rootlets in fleshy ovary around the seed and made it useless for consumption because of its bitter taste.

The frequency of viviparous germination was high (19/100 fruits) in fruits harvested after ripening, and was low (4/100 fruits) in fruits harvested before ripening. So early harvesting of fruits before ripening can reduce the damage of fruits by viviparous germination of their seeds.

I thank Prof. R. Bothi, Head of the Department of Botany, Vivekananda College, Agasteeswaram for references and suggestions.

June 15, 1996

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28. *CEROPEGIA BULBOSA* VAR. *LUSHII* (GRAH.) HOOK. F.: A NEW FOOD PLANT FOR PLAIN TIGER BUTTERFLY *DANAUS CHRYSIPPUS* (LINN.)

While carrying out the survey of genus *Ceropegia* (Linn.) Family *Asclepiadaceae* on 15th September, 1995, at Appachi Wadi near Kolhapur in Maharashtra, we found an egg of a butterfly on the undersurface of the leaf of a *Ceropegia bulbosa* var. *lushii* (Grah.) Hook.f. We collected the egg and brought it to Mumbai along with the food plant. The larva hatched out on 17th September, 1995. It fed upon the leaves of *C. bulbosa* var. *lushii* It pupated on 26.ix.95 and on 4.x.95, an adult of the Plain tiger *Danaus chrysippus* (Linn.) emerged from the pupa.

C. bulbosa var. *lushii* is a xerophytic plant. The leaves are long, linear, thick and fleshy. *D. chrysippus* is mainly found in open country and is less common in damp, forested hilly regions (Wynter-Blyth, 1982). Earlier, Pennington (1978) had recorded *Ceropegia* sp. as one of the food plants of *D. chrysippus* in Ackery and Vane-Wright (1984).

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December 21, 1995

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